POWER

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PHILIP W. SWAIN, *Editor*

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PESSIMISTS

• THERE IS SUCH A THING as a healthy man stubbing his toe. And there is such a thing as being sick unto death with pneumonia or smallpox. They are not the same. The power field has its aches and pains. Under the amplification of innumerable microphones they sound like pneumonia. Viewed through the telescope of time perspective they are obviously nothing but stubbed toes. No sane man, viewing and knowing the power field as a whole, can be pessimistic as to its future.

• THIS DOES NOT MEAN that all existing types of ownership, rate structures and classes of equipment will always be cherished. The world changes always, and now with increasing speed.

• FUEL AND LABOR COSTS shift absolutely and relatively. Brains are at work in a hundred specialties to gain a competitive advantage through better or cheaper equipment. Some types and classes of equipment will gain ground and others drop back. Individual stubbed toes will be the certain result.

• POLITICAL PRESSURE and the competition of private plants inevitably influence utility rates. Loads swing one way or the other among central stations, municipal plants and industrial plants. In each shift some toes are pinched.

• THESE FORCES ARE EVERYWHERE in action, and the resulting grand chorus of complaints from individual sufferers is so great that one who did not know might imagine the power field to be pretty sick, whereas the very opposite is the fact.

• IN SPITE OF POISON IVY and barked shins, the power field as a whole is the very model of health and vitality, blessed with brains without end and, above all, with a public necessity that is irresistible.

• LET'S GET DOWN TO BRASS TACKS. After food, water and shelter (all tied up with power), does any physical necessity exceed that of power? NO! Could anything replace power in some form? NO! Will the country in the future be content to use less power? NO!

• CAN POWER BE GENERATED, transmitted and applied without machines? NO! Can power machines be designed, built, installed and operated without the help of men with intelligence and initiative? NO! Is it possible to hold such men in any specific field for a long period without rewards commensurate with those obtainable by similar ability in other fields? NO!

• THE CONCLUSION IS INEVITABLE that the power field will continue to offer increasing rewards to those who can apply power to the public service and who have sufficient initiative and versatility to do this fundamental job with the best tools in the way of finance, ownership and equipment each new decade may offer.

CROSS-CHECK

A LOT of "record" efficiencies are simply mistakes, the result of unchecked instrument readings, blindly accepted as correct and final. Too bad, for it sometimes gives the careless engineer undeserved credit for achievements that never happened! Instruments should be calibrated at regular intervals. Even more important, the instrument installations should be such that cross-checks are available from the regular operating records. Steam-flow and feed-flow meters, for example, check each other. Separate metering of steam to engine room and plant departments checks the meter reading of total steam production. Checked and cross-checked instrument readings are the best evidence of honest operating records.

POWER FROM HOT WATER

MANY PLANTS still face the problem of increasing the amount of by-product power produced from a given flow of process heat. Where higher throttle pressures are not feasible, stage heating of hot water for process or building heat may give the necessary increase in power. The water is first warmed by circulating it through a surface condenser operated at, say, 5 lb. absolute, the additional power coming from the vacuum carried on the turbine served by this condenser. This raises the water temperature to 160 deg. approximately. Further heating may be done with steam bled at atmospheric pressure. The hook-up (discussed by Norris Gove in the July number) has been known for many years, but engineers when laying out industrial plants frequently overlook its possibilities.

LET'S ARGUE ABOUT GAS

POWER this month starts another argument, deliberately and we believe to practical purposes. Gas producers for power generation "are distinctly a dead issue"—ask any U. S. engineer. "They were tried years ago and flopped badly." Some of our keenest analysts think they will stay dead—but not all—not Mr. Lustig, for example. See page 458. *Power* doesn't say that Lustig is right, but it does think his points are worth a hearing. If you agree, or disagree, write in briefly. A good argument will air the facts and we all may learn something we never knew or have forgotten. A big point not stressed by Lustig is the higher ratio of by-product power to process heat with producer gas power. This would make the *type* of industry a deciding factor in the choice between steam and gas. Note the relative figures in Table I, and the 3 mill cost for 10,000 B.t.u. effective heat in Table II.

FREE-PISTON COMPRESSORS

IN POWER'S "Current Comment" for July, Boyd Candlish pointed to an interesting European development, the diesel compressed-air locomotive. It sounds complicated and impracticable—free-piston diesel compressor delivering compressed air to a receiver, which, in turn, supplies air to the driver pistons. Some locomotives preheat the compressed air with exhaust heat before delivery to the cylinders, a further complication to improve efficiency. In spite of appearances to the contrary, other engineers consulted agree with Candlish that this type of unit has real possibilities because it is cheaper and more flexible than the diesel-electric locomotive and far more efficient than the steam locomotive. A prime factor seems to be the very low cost of the free-piston diesel compressors. It is reported that a 20-hp. factory-type compressor on wheels can be purchased abroad for $400. Even at a considerably higher price, such compressors should find many applications here for compressed-air service in stationary plants.

TEST SAFETY DEVICES

THE MERE FACT that a machine has run sweetly for years is no proof that trouble will not come tomorrow. Remember the "one hoss shay." Certain types of equipment may go out suddenly and without warning. A case in point is a recent turbine failure reported from South Wales. A 5,000-kw. machine designed to operate at 3,000 r.p.m. was completely wrecked. The unit, installed in 1923, had been in service for four months without shutdown prior to the accident. Governor and overspeed stop both failed to operate. The machine reached 4,200 r.p.m. and crashed before the operator could close the stop valve. Governor and stop parts had been damaged and clogged with sediment and dirt.

Had the safety devices been tested at regular intervals, regardless of their apparent condition, this accident would have been avoided. Continuous operation for long periods, without shutdown for inspections, may make nice records, but unquestionably it's playing with fire.

POWER STANDS FOR

1. Making power when it should be made
2. Buying power when it should be bought
3. Cheaper power through modern equipment
4. Easier financing of equipment purchases
5. Better use of by-product heat and power
6. Operating methods that save money
7. Less waste in transmission and application
8. Prevention of smoke, within reason

SINGLE-UNIT POWER PLANT Has High Reliability

Elevated coal tank on side of power plant has two spouts, one leading to the stoker and the other to storage

Plant, comprising a 4,670-sq.ft., 435-lb. boiler and a 500-kw. turbine-generator, is practically automatic in its operation and is giving 100 per cent service supplying process steam and power. A 60-kw. gasoline-engine generating set provides emergency, night and week-end service

TAYLOR AND COMPANY, Norristown, Pa., in 1932 built a new plant at Betzwood, Pa., to manufacture vulcanized fibre and phenol fibre. Large quantities of steam would be required for process at 150 and 25 lb. gage; therefore it was decided to install a high-pressure boiler plant and generate all power in a turbine exhausting at 25 lb. gage and bleeding at 150 lb. Estimates showed that demands for process steam would usually exceed that for power, consequently the latter could be supplied at very low heat consumption, about 4,000 B.t.u. per kw.-hr.

The plant is in a rural district on a main-line railroad where there are few restrictions on building designs. The company was therefore free to work out a design that would be reliable and easy to operate and produce a high-grade product at low cost. This idea was also incorporated into the power plant, which has been made practically automatic in its operation, yet its design is comparatively simple.

Because of high reliability of modern power-plant equipment conservatively designed, it was decided that for the initial manufacturing capacity a single boiler and turbine would take care of power and steam requirements satisfactorily. Nearly two years' experience operating this plant shows that it can be depended on to give 100 per cent service when it is required.

Conditions alter requirements, but experience with this plant and others having little or no reserve capacity installed, indicates that the large investments commonly made in reserve capacity are often unnecessary. Because large excess capacity was considered necessary, many proposed industrial power-plants have been found uneconomical to build, while, if the installation of spare capacity had been deferred until a later date when the manufacturing plant was enlarged, the power plant would have been a good investment.

Steam is supplied by a boiler having 4,670 sq.ft. of heating surface and designed for 448-lb. gage working pressure and 150 deg. F. superheat. An integral economizer is provided that reduces flue-gas temperature to an average of 425 deg. F. at the economizer gas exit. Coal is the fuel used and is fired by a turbine-driven underfeed stoker.

Although oil might have been selected if future price trends could have been predicted, it was considered that oil prices were likely to increase more rapidly than those for coal and the latter could be readily obtained.

Because of the comparatively low rating, maximum 250 per cent, at which the boiler was to operate, very little refractory trouble was predicted in the furnace; therefore it was felt that an investment in water walls was not justified. A clinker grinder was not provided on the stoker, it being felt that the comparatively low rating at which the stoker was operated would prevent serious clinker trouble. Experience has proved these predictions correct.

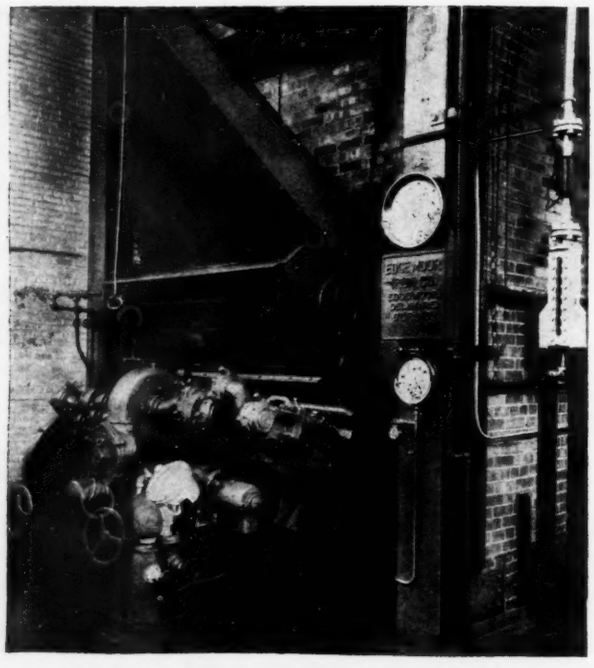
Ashes fall into a pit below the stoker from which they are raked at intervals into a rail car which carries them outside the plant. Here the ashes are dumped into a truck and used for fill on the property.

The boiler is also equipped with a forced- and an induced-draft fan, each driven by a slip-ring motor to give 50 per cent speed control.

Coal is received on cars that come to the plant on a ground-level track and is dumped into a track hopper. From the hopper it is fed into a crusher by an apron feeder and is then delivered by a bucket elevator to a 75-ton elevated circular steel storage hopper. Two spouts lead from this hopper, one to the stoker and another to a coal-storage pile adjacent to the track hopper. Only a small amount of coal is stored, just enough to take care of minor difficulties that might develop in deliveries. This storage is close to the track hopper so coal can be raked into it easily and delivered to the elevated storage again when needed.

Coal is not weighed to the stoker, but in the future when the plant is enlarged a weigh larry will be installed. The stoker carries an indicating coal meter calibrated to indicate the rate at which coal is being fed to the stoker. From this reading and that of the indicating boiler-load meter a fairly close check can be made on operation. This is also checked over longer periods, such as each week, by the total steam produced and coal burned, based on weight of coal received.

The boiler is also equipped with automatic feedwater regulator, high- and low-water alarm, eye-line water columns, continuous blowdown and automatic combustion control. On a boiler meter panel are mounted the master regulator for the automatic combustion control, a three-point draft gage, a boiler-pressure and total steam-temperature recorder, integrating and recording steam flowmeter, a large-dial boiler-load indicator and a meter that records steam flow, CO_2 and flue-gas temperature.

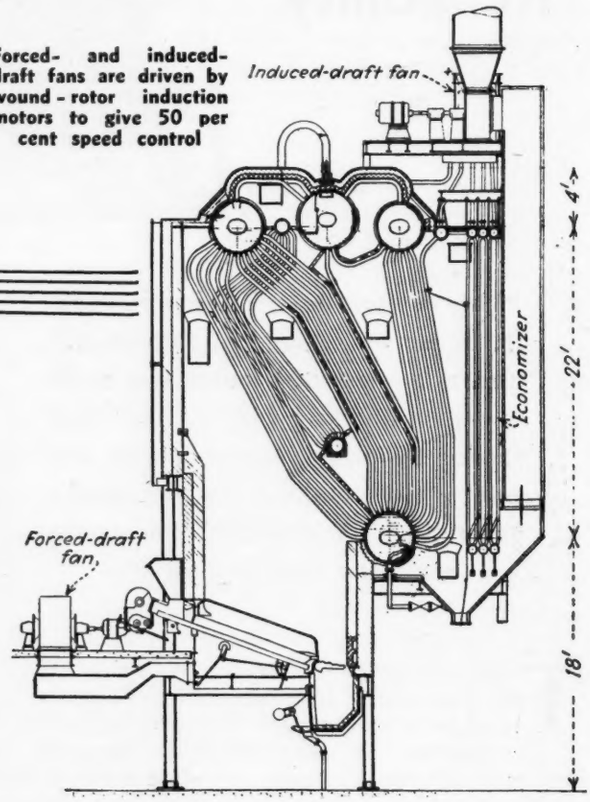


Coal-feed indicator converts stoker speed into weight of coal being supplied to the furnace

The automatic combustion control regulates five factors: Stoker speed, damper position, forced-draft fan speed, induced-draft fan speed, and differential draft pressure across the boiler. After the combustion and boiler equipment have been adjusted for a certain standard of operation, these conditions will be closely maintained over long periods with little attention. Variations in quality of combustion are easily detected from meter readings, and if dangerous conditions are approached, such as high or low water, attention is called to them immediately by automatic alarms.

Feedwater is taken from several deep wells on company property. This water is hard, most of the hardness being carbonate. It also contains some sulphate hardness and organic matter, which along with the carbonate hardness must be removed before the water is used in a high-pressure boiler. Based on an analysis of the water and the boiler requirements an automatic lime-

Forced- and induced-draft fans are driven by wound-rotor induction motors to give 50 per cent speed control



inversand, zeolite water-softening system was installed. This treatment substantially reduces the total solids in the water and consequently reduces amount of blowdown necessary. It clarifies the water of troublesome organic material, thereby minimizing the tendency to foaming and priming. Sulphate-carbonate ratio is automatically improved so that only a minimum of sulphuric acid is required to obtain a sulphate-carbonate meeting A.S.M.E. recommendations. Alkalinity is reduced to less than one grain per gallon and free CO_2 to less than four parts per million. The water is made 100 per cent soft by the standard soap test and by gravimetric chemical analysis contains less than three parts per million of total hardness.

This water has proven ideal for use in the boiler. After over one year's operation the boiler was opened and inspected by the plant's engineers and engineers

of the boiler and the insurance companies. It was found to be just as clean and in as good condition as when put into operation and without any signs of scale formation or boiler plate deterioration. Outside of time out of service for periodic inspection, experience to date indicates that the boiler can operate for many years before requiring to be out of service for repairs or replacements.

Power is generated in a single 500-kw., 440-volt, 60-cycle turbine-geneator operating at 3,600 r.p.m. with direct-connected exciter. The generator is totally enclosed and cooled by recirculating the ventilating air through a water cooler. Temperature recorders with alarms are provided on the lubricating oil going to the turbine and generator bearings, and on water from the oil cooler and air coolers.

Generator windings have temperature coils in them, and the three showing the highest temperature have been brought to the switchboard and by a suitable switch can be connected to a temperature indicator. In addition to the other regular switchboard equipment, generator voltage is controlled by an automatic regulator. Bleeder pressure on the turbine is maintained by automatic control, as is also the amount of superheat in the 150-lb. process line. Pressure and temperature recorders are connected to the 150-lb. and the 25-lb. process lines to give a record of the steam conditions maintained in these lines.

Principal Equipment in Power Plant of Taylor & Company

Boiler, superheater and economizer.....Edge Moor Iron Co.
Number 1: boiler heating surface, sq.ft., 4,670; max. steaming capacity lb. per hr., 26,000; gage pressure at boiler drum, 435 lb.; superheater surface, sq.ft., 1,100; total steam temperature, deg. F., 600; furnace volume, cu.ft., 510; max. B.t.u. liberated per cu.ft. per hr., 32,700; economizer heating surface, sq.ft., 1,450; gas temperature leaving economizer, deg. F., 425.
Breechings.....Edge Moor Iron Co.
Stack.....Edge Moor Iron Co.
Water column.....Yarnall-Waring Co.
Eye-line water-level indicator.....Yarnall-Waring Co.
Feedwater regulator (copes).....Northern Equipment Co.
Continuous blowdown.....Cochrane Corp.
Soot blowers.....Diamond Power Specialty Corp.
Safety valves.....Crosby Steam Gage & Valve Co.
Non-return valves.....Crane Co.
Blowoff valves.....Yarnall-Waring Co.
Coal- and ash-handling systems.....Beaumont-Birch Co.
Automatic combustion control.....Mason-Neilan Regulator Co.
Stoker, underfeed.....Westinghouse Electric & Mfg. Co.
Forced-draft fan, 1, capacity, 9,800 c.f.m....B. F. Sturtevant Co.
Induced-draft fan, 1, capacity, 16,600 c.f.m...B. F. Sturtevant Co.
(Fans driven by 10 and 15 hp. Westinghouse slip-ring motors, arranged for 50 per cent speed control.)
Deaerating feedwater heater, capacity 50,000 lb. per hr.; final feed water temperature deg. F. 277.....Cochrane Corp.
Feedwater treatment.....Hungerford & Terry Co.
Boiler feed pumps, 2, steam driven, Worthington Pump and Machinery Corp.
Turbine generator, 1, 500 kw.; 3,600 r.p.m., bleed 150 lb., exhaust 25 lb. gage.....General Electric Co.
Switchboard.....General Electric Co.
Desuperheater.....Elliott Co.
Desuperheater control.....Bailey Meter Co.
Reducing valves.....Atwood & Morrill
Pressure relief valves.....Atwood & Morrill
High-pressure valves.....Crane Co.
Low-pressure valves.....Crane Co.
Traps.....Strong, Carlisle & Hammond Co.
Piping.....W. K. Mitchell Co.
Pipe covering and heat insulation.....Philip Carey Co.
Pipe covering and heat insulation.....Keasbey & Mattison Co.
Boiler meter board.....Mason-Neilan Regulator Co.
Steam flowmeters.....Republic Flow Meters Co.
Steam load indicator.....Republic Flow Meters Co.
CO_2 recorder.....Republic Flow Meters Co.
Pressure and temperature recorders...Republic Flow Meters Co.
Pressure and temperature recorders.....Bristol Co.
Master pressure gage.....Consolidated Ashcroft-Hancock Co.
Draft gages.....Republic Flow Meters Co.
Coal-feed indicator.....Westinghouse Electric & Mfg. Co.
Air Compressor.....Worthington Pump & Machinery Corp.
(Air compressor driven by General Electric motor.)

From the foregoing it will be seen that the plant is practically automatic in all its functions except for starting and stopping and that recording meters are installed on all quantities that have an influence on the efficiency and reliability of the plant's operation. The recording meters have proven so satisfactory that no log is kept of the plant's operation, the recording charts being used instead. These provide the operating engineer the information necessary for a carful check on operation. The charts each morning are sent to the executive responsible for plant operation, who studies them to see that the desired conditions have been maintained.

For service over week-ends or in emergencies a 60-kw. generator driven by a 100-hp. gasoline engine has been installed. This unit is of a size to supply the essential motors to provide for the safety of the plant and to supply power for lighting. Fuel for an oil engine would cost considerably less than for a gasoline engine, but the cost of an oil engine is much higher than that of a gasoline engine of equal capacity. In this case the low cost of the gasoline engine, combined with its ease of operation and the short periods that it will be required, more than outweighed the factors in favor of the oil engine.

MORE WHENS AND WHYS

By THEO. J. DICK
Milwaukee, Wis.

CONTINUED from the May number. Try these; then compare your answers with those on page 453 and 460.

1. What is the most familiar conception of force? How can force be measured?
2. What are the three laws pertaining to force and motion?
3. If two men pull on a rope in opposite directions, each exerting a force of 50 lb., does the rope resist a force of 50 or 100 lb.?
4. If a body weighs 100 lb. and a force of 99 lb. is exerted upward—is work done?
5. If a force of 10 lb. is exerted on a body to move it 1 ft. in 10 min. is the same amount of work done as if the body were moved in one minute?
6. What is a foot-pound?
7. If a hoisting engine lifts 2,000 lb. a distance of 100 ft. what work is done?
8. With a water pressure of 100 lb. per sq.in. in the cylinder of an 8x10-in. pump, what is the work done per stroke?
9. What is power?
10. 500,000 lb. of water were lifted 100 ft. in 1 hr. What horsepower was developed?
11. Is it correct to say "horsepower per minute," "horsepower per hour," etc.?
12. a. How many foot-pounds of mechanical energy equals one B.t.u. of heat energy?
    b. How many foot-lb. of energy are contained in one lb. of coal having 14,500 B.t.u. of heat energy?
13. How many heat units equal one horsepower-hour?
14. The area of a piston of a double-acting engine is 70 sq.in. The steam-pressure is 100 lb. per sq.in.
    a. Find the total force acting on the piston.
    b. Find the work done per stroke (without cut-off) if the length of the stroke is 12 in.
    c. Neglecting the area of the piston rod, find the work done per minute if the r.p.m. is 50.
    d. Find the horsepower.
15. a. An engine delivers 2,000,000,000 ft.lb. of work per 1,000 lb. of coal. The coal contains 14,500 B.t.u. per lb. What per cent of the total energy is transformed into useful work?

POINTERS
ON
BURNING FUEL OIL

By A. G. SOLOMON

FUEL OIL must be heated before it will burn satisfactorily under a boiler, the proper temperature depending on the grade of oil and on burner and furnace design. As a rule, the temperature will be between 185 and 210 deg. at the nozzle.

Oil is heated in much the same manner as water in a closed-type heater, passing through coils surrounded by steam. In a heating plant, the pressure carried on the boiler is seldom higher than 15 lb. per sq.in., whereas the pressure of the fuel oil in the heating coil varies from 50 to 150 lb.

Steam direct from the boiler or main steam header enters the shell or steam space of the heater at a point near the top. Condensation is usually returned to a receiver through a steam trap.

Consider for a moment what happens if one of the coils in the oil heater should rupture or develop a leak. A small leak may continue for days, weeks or even months before it is discovered. Often the first indication is noticed at the time the boiler is opened for cleaning or inspection. Oil will be found on the tubes and in the drums of the boiler. Sometimes the warning is given by oil blocking the trap, valve or radiator of the steam heating system.

It is readily seen how much oil can enter the system through a small leak when we consider that heating plant boilers are frequently not opened for cleaning more than once a month, and generally once every two or three months. Oil that comes from a small leak will pass into the boiler with the condensation from the oil heater.

If one of the coils in the heater bursts or develops a large-sized leak, the oil will be forced into the steam space of the heater at a rapid rate. The condensate line in the trap cannot take care of much oil, and the steam space will soon be filled. Then the oil will be forced directly into the main steam header and possibly into the boiler by way of the steam line that supplies the heater.

In a case that I witnessed, the boiler attendant did not know anything was wrong until the temperature of the oil dropped so low that poor combustion resulted. About the same time it was noted that oil was showing in the water glass of the boiler.

By the time the trouble was located and the ruptured heater was shut off, oil estimated at between 3 and 5 barrels had entered the boiler. This estimate was checked by readings of the meter on the fuel-oil line and comparison with the usual amount of fuel burned. Any engineer or fireman will understand what this condition means.

To make matters worse the boiler with oil in it had to be kept in service for about eight hours longer. Its operation resulted in oil being distributed to every part of the heating system and later caused trouble for several months by blocking of steam traps and valves, even some of the smaller pipe lines.

Fortunately, the removal of oil from the surfaces of the boiler was accomplished quickly and easily, as for some reason this grade of fuel oil did not cling tightly.

The spare heater was put in service and all went well for about another month, only the temperature of the oil could not be carried high enough to prevent smoke. The first heater had been repaired and was ready to use when a coil in the second heater burst.

This rupture was noticed at once, for the condensation from the heater was flowing direct to the sewer and the end of the line was in plain view of the fireman.

When repairs were made it was found that the coils were heavily coated on the inside with sediment from the heated oil. Such accidents do not happen often, but the plain fact that they can happen should be a warning to those who use this type of equipment. One remedy is to pipe the outlet of the trap to the sewer instead of into the return of the heating system condensate. The loss of steam caused by this is small.

The boiler-room engineer who is considerate of the safety of his firemen and equipment will enforce the following operating precautions:

First—Be sure the floor of the furnace is smooth, free from cracks and low places. The floor should have a slight pitch toward a drain. This drain should not be piped to a sewer but arranged so any oil coming from the furnace can be plainly seen.

Second—Keep the floor of the furnace clean. Do not allow carbon, soot or dirt to collect. Dirt will hold unburned oil and may cause a backfire.

Third—Do not allow any leaking valves in the oil-burning system. As soon as a valve is known to leak, repair it.

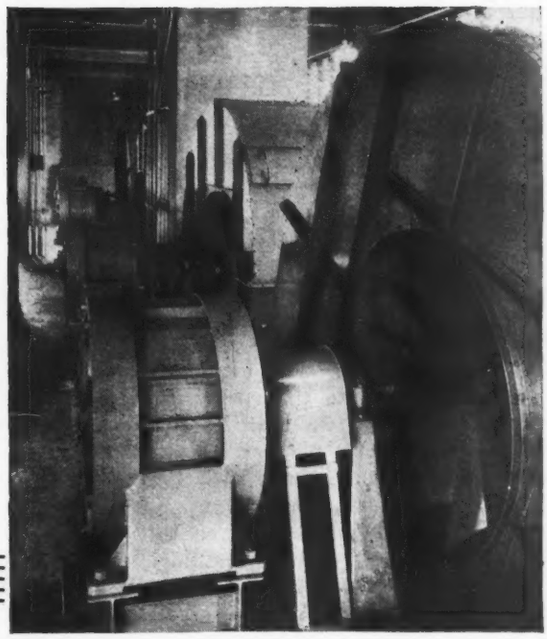
Fourth—When an oil fire is burning, some one should be within sound and reach of the burner. Something may happen to cause the fire to go out (a small amount of water passing through the burner, or a temporary blocking of the small openings of the burner, or the oil pressure dropping). If the fire goes out, unburned oil will enter the furnace, and there is real danger of explosion when this unburned oil and liberated gases become heated by the hot brickwork of the furnace. This danger is minimized if the fireman is right there to shut off the oil as soon as the fire goes out.

TWO-SPEED MOTORS DRIVE LARGE VENTILATING FANS

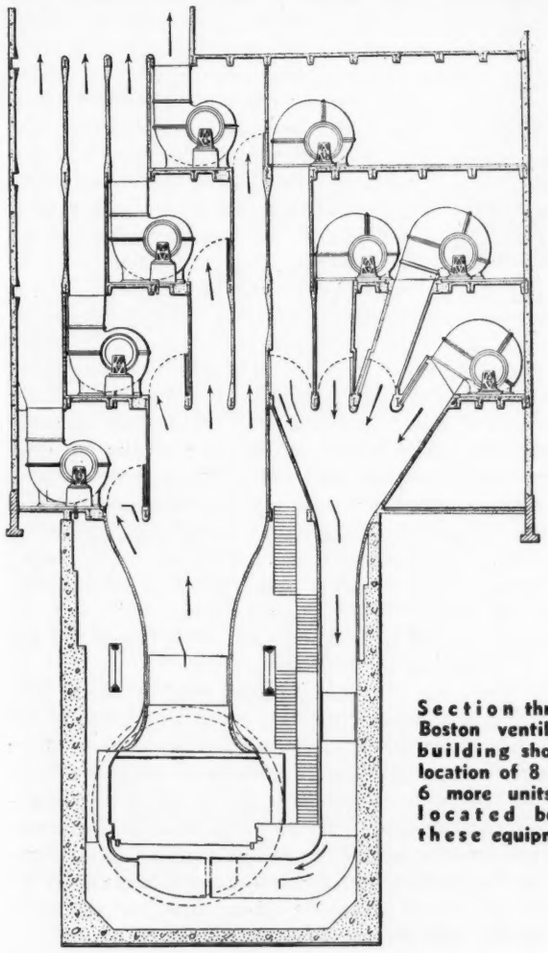
WITH completion of the East Boston Traffic Tunnel, 6,270 ft. long and 31 ft. in diameter, one of the world's largest vehicular tubes goes into operation. Providing ventilation for such a project involved supplying over 1,000,000 cu.ft. of fresh air per min., which will change the entire volume of roadway air 40 times per hour. Two large ventilation buildings, one at each side of the harbor, house the fans. Each building has 14 fans, 7 blowers and 7 exhausters, each of approximately 93,000 c.f.m. at 2.5 in. water pressure, with one fan in each set reserved as a spare.

Arrangement of four blowers and four exhausters in the Boston building is shown. Outlets of the blowers are connected to one chamber by short ducts, the area of which can be regulated by special dampers. Air going through the exhaust ducts is regulated in the same manner. Each exhaust fan is in a small separate chamber.

Since seven fans are connected to one main duct, it was essential that they have characteristics which permit operation in parallel. Total pressures specified were based on resistance when all six fans are operating at the same time.



Four Buffalo intake fans in one of the blower rooms driven by Lincoln 50-hp. squirrel-cage two-speed motors



Section through Boston ventilation building showing location of 8 fans; 6 more units are located behind these equipments

To meet the specifications, 28 fans with the same size housings, wheels, shafts and bearings were selected. These have fixed inlet vanes to turn the entering air in the same direction as the rotating fan wheel to decrease shock losses, aid efficiency and give a non-overloading horsepower characteristic. By utilizing different angles of these fixed vanes with respect to the rotor, different characteristic curves can be obtained from the same fan housing and wheel. Thus it was possible to use 28 duplicate fans and by using two different vane angles, meet the different ratings called for in the specifications at approximately the same speed, which was desirable for both construction and operating reasons.

Each of the 28 fans is directly connected to a two-speed, 50- and 6.25-hp., 450- and 255-r.p.m., squirrel-cage motor operating on 440-volt, 3-phase, 60-cycle current. Both direct- and alternating-current types of motors were considered for operating the fans at various speeds and under many conditions. Squirrel-cage motors were chosen because they are more economical. The two-speed type was selected in preference to 3- or 4-speed designs in order to simplify the control. It was also estimated to be more economical to have more two-speed units than a smaller number of units of the 4-speed type.

TECUMSEH ENGINEERS WIN BATTLE WITH

By F. A. RUMATZ, and O. K. JOHNSON
Kansas Power and Light Co.

SINCE the installation in 1930 of a 25,000-kw. turbine addition to the Tecumseh plant of Kansas Power & Light Co., large quantities of sand drawn into the circulating water system from the river have at times threatened the plant with complete shutdown until a cure for the difficulty was found about a year ago.

Sand at this point in the river has been found to be a natural condition, one that has always existed. No difficulty, however, was experienced prior to the operation of the 25,000-kw. unit, because the velocity of the circulating water was not particularly high. With the larger unit in operation, the inrush of water at the intake pulls sand from the river into the tunnel and plant.

The present plant contains two old 6,000-kw. turbine generators, a 15,000-kw. unit installed in 1927, and the 25,000-kw. turbine. Condensing water facilities for these four units consist of an intake house and a double-barreled concrete tunnel to convey the condensing water by gravity to a point below the condenser-pit floor. The intake house, about 1,200 ft. downstream from the plant, is equipped with a traveling screen of ½-in. mesh.

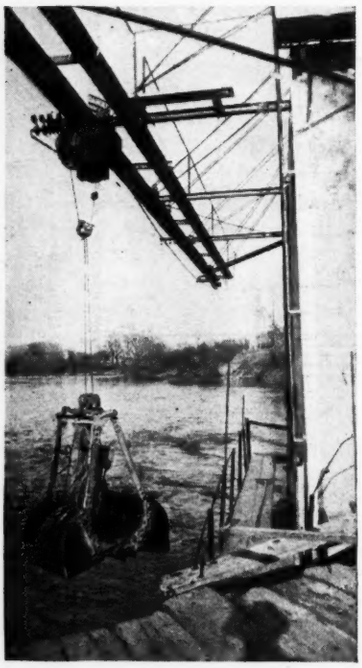


Fig. 1—Clamshell hoist and I-beam solved the sand problem

Sand pumped up from the intake tunnel was thrown into the top waterbox of the large condenser with sufficient force to jam slugs of it into the tubes. During sandy periods it was not unusual to find as many as 1,500 to 3,000 of the 8,500 tubes completely stopped up with sand after about two weeks of operation. In addition, as much as 4 ft. of sand accumulated on the floor of the intake house and extended in a lesser degree toward the plant on the floor of the tunnel for almost its entire length. This not only restricted the flow of water in the tunnel, but the sand became so deep on the floor of the screen house that it clogged up the lower sprocket of the traveling screen, causing it to break on several occasions. Complete shutdown of the plant was averted several times only by calling out large maintenance forces to repair the damage hastily.

A number of devices and schemes were tried to alleviate the trouble, but most of them availed little, though some were helpful. A survey of the river bed showed a rock riffle existing just upstream from the intake, and a large pit in the river bed immediately in front of the circulating water inlet. River velocity was moderately high over the riffle, but low enough over the pit to allow sand to settle and fill it. The rush of water to the intake opening carried the sand through and on into the tunnel. Fig. 3 shows a section of the river and illustrates the formation of sand on the river bed in front of the screen house.

After we examined the direction of flow past the intake, a deflector was constructed along the river bank and just upstream from the intake opening. A dock had been built at that point, and the deflector was formed by lowering wooden barriers into the water at the side of the dock. It was thought that this would throw the river current out away from the intake house and cause the sand to be deposited at a point farther out in the river. However, eddy currents were set up around the downstream end of the barrier, causing more sand than before to pile up near the opening.

A system of water jets was tried by connecting a 150-lb. wash water line to a header placed horizontally near the bottom of the intake and extending across its full width. Small pipe jets were attached to this header at intervals of a few inches and were directed outward against the flow of sand. Experiments with this arrangement proved it to be of some help, but it fell far short of defeating the trouble.

With the same principle in mind a 12-in. sluice pipe was laid in the sandy river bed about 15 ft. out in the river and about 10 ft. downstream from the intake opening. It was directed downstream with the hope that the sluicing action of the water would open a channel and that the action of the river through the channel would clean away the rest of the sand. The arrangement was not effective. A small channel was cut in the sand by the water from the 12-in. pipe, but the river velocity was too low to assist any further.

RIVER SAND

Following falls in river stage, sand was regularly carried into the circulating water intake, clogging the condenser tubes and traveling screen. A clamshell hoist cured this trouble

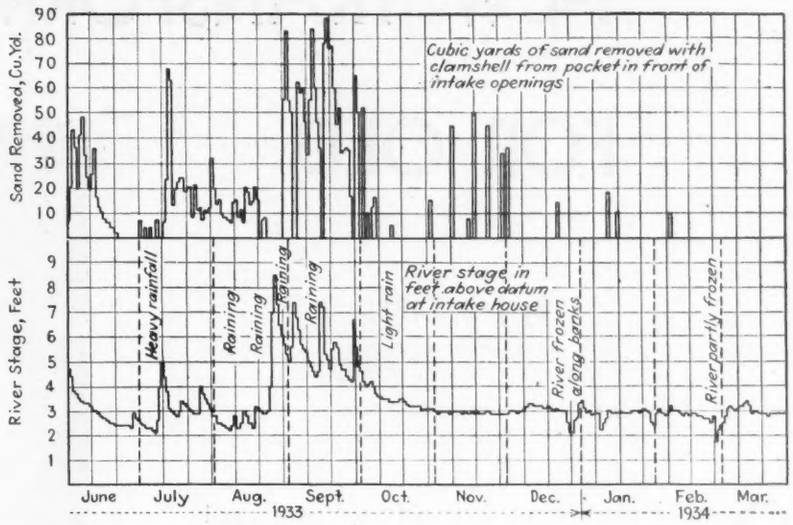


Fig. 2—Record of sand removal and river stage

It was finally decided to attempt complete removal of sand in front of the screen house as rapidly as it became troublesome. A rig was constructed in front of the intake house which is now effectively combating the trouble that had existed for nearly four years. A long I-beam running across the entire front of the screen house and extending beyond the downstream end of the building about 20 ft. is supported by hangers and brackets away from the front screen-house wall. It forms a track about 20 ft. above the normal high stage of the river for a small trolley with electric hoist. A clamshell bucket of ½-yd. capacity is slung from the motor-driven hoist and is used to dredge sand from the pit near the intake opening. Sand is lifted and deposited downstream from the intake house as far as the I-beam track will permit. Normal river flow has been found sufficient to move this pile of sand on downstream.

The clamshell dredge was placed in service almost a year ago and has been overwhelmingly successful compared to all other methods attempted. During the most severe periods, from a sand-flow standpoint, only eight hours' operation of the clamshell dredge are required per day to keep the pit fairly clean of sand in the vicinity of the intake opening. Immediately in front of the opening, the sand level in this pit is kept about 5 or 6 ft. below the bottom of the intake house floor. The hoist and clamshell rig cost about $1,350 erected and ready for operation.

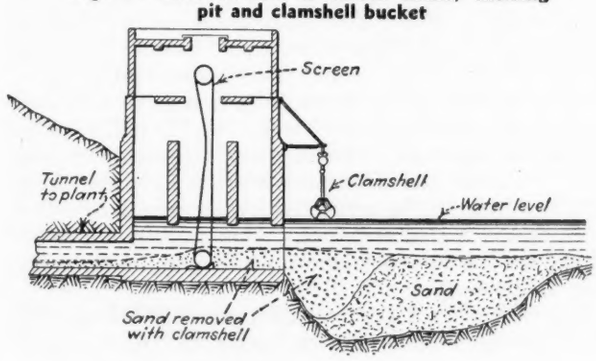
Heavy sand flow occurs when the river recedes after a high stage. The accompanying chart, Fig. 2, indicates the river stages throughout a ten-month period and shows the quantities of sand removed from the pit with the dredge each day during this period. It will be noticed how regularly, following a fall in river stage, it is necessary to dredge the pit and that the amount of sand accumulating bears a close relation to the rapidity of the fall.

Practical elimination of sand from the condensing water system has resulted in considerably improved vacuum on the large unit because of the reduction in tube stoppages. It also reduced condenser cleaning by about 80 per cent. Before installation of the electric hoist it had been necessary to clean the condenser about three times per month during the spring, summer and fall. Using as many men as possible, it took from 10 to 16 hr. to clean the large condenser. The cost of such cleaning is around $50, not including the loss of plant efficiency during operation of the smaller machines.

A sand pump, driven by a 75-hp. motor, was provided for removing sand from the bottom water box of the condenser. In the past this pump operated almost constantly, but since the installation of the sand dredge it has been found that about 20 min., operation out of every four hours is sufficient, thus materially decreasing station auxiliary power costs.

The thick bed of sand which had accumulated on the screen house floor has been eliminated, and thus the wear on the screen and its traveling mechanism is reduced. It has also eliminated screen breakage, which had seriously jeopardized continuity of electric service.

Fig. 3—Cross-section at screen house, showing pit and clamshell bucket



Fly Ash Cleans Turbine—Fly ash has been used successfully to clean hard scale from turbine blades. It is blown by compressed air through a regular Gunite machine. Two men cleaned scale from a 50,000 kw. unit in half the time formerly required for scraping. Fly ash does not erode the blade, whereas sand, which is highly abrasive, not only removes the scale but also some of the blade metal.

NEW TRANSFORMERS FOR OLD

By J. B. GIBBS
Transformer Engineer
Westinghouse Electric & Mfg. Co.

Deion gaps at A protect transformer insulation from being punctured by surges

DOES it pay to throw away old transformers and replace them with new ones? Obviously, no general answer can be given because many factors are involved which differ with conditions. Certain principles can be applied, however, which will lead to the right answer.

To arrive at these principles it is necessary to consider the items of cost in operating a transformer, which will vary with conditions and those making the estimates. Figures for costs are given in a paper by Marshall and Snow in the N.E.L.A. Bulletin for July, 1931, and are regarded as typical.

Interest and taxes are evidently items in the cost of operation. Besides these an annual amount must be charged against the transformer for depreciation so that its value will be written off during its life. Fourteen per cent is frequently assumed for interest, taxes and depreciation.

Iron loss requires actual power taken from the line as long as the transformer is excited, whether or not it is delivering power. Recognizing this fact, designers have done much to reduce iron loss, as is shown by the table, which gives iron and copper losses for high-grade 2,300-volt distribution transformers. The improvement has resulted from better designs and better core material.

Copper loss—that is, the I^2R loss in the windings, varies as the square of the load current.

Regulation is defined as the percentage rise in voltage when full load is thrown off the transformer, rated voltage being maintained on the primary. It depends on the resistance and reactance of the transformer, but the higher the power factor of the load the less the effect of reactance. With loads at unity power factor, the regulation is practically equal to the resistance drop —that is, the per cent regulation practically equals the per cent copper loss. Regulation is often disregarded as an item in the cost of operating a transformer. It has, however, a definite effect as may be seen by considering a distribution system. Voltage regulators are set to maintain normal voltage at certain points in the primary mains. Voltage drop in the transformers, therefore, means decreased voltage delivered to the load, which may cause loss of production to the power user and loss of revenue to the power company where power is purchased.

The factors previously mentioned can be given pretty definite values. Other characteristics cannot, although they affect the desirability of the transformer, and they may have different values, depending on whether the transformer is on the lines of a power company or in an industrial plant. The weight and size of distribution transformers, for a given output, have shown a steady decrease. At the same time appearance has been improved. Insulation strength and permanence are much better in modern transformers than in the older types, and the probable life of the transformer is therefore longer. Some modern transformers are also provided with auxiliary devices which make them comparatively immune from lightning, and thus insure continuity of service.

With these factors in mind, two questions may be raised. First, if a damaged transformer has been removed from service should it be repaired, or replaced with a new transformer? And second, should an old transformer now in service be removed and replaced?

One large operating company has answered the first question by assuming that repairs will prolong the life of the transformer five years, and that the difference in cost of operating the old transformer and the new lies in the fixed charge on the increased investment and the cost of iron loss (see *Power*, Oct. 11, 1927). The economical cost of repairs, then, is anything less than five times the difference between fixed cost plus iron-loss cost on the new transformer minus iron-loss cost for the old transformer. This neglects the effect of copper loss and regulation, which may be considerable in some cases.

For example, a 25-kva. transformer built before 1907 has been taken out of service for repair. Assume that

a new 25-kva. transformer will cost $230. It is desired to amortize the cost of this transformer at 5 per cent per year, and the interest rate on the investment is 6 per cent. Then the fixed charges will be 230 × 0.11 = $25.30. The iron loss in the new transformer, as given in the table, is 120 watts. Assuming the transformer to be on the line continuously, then the yearly iron loss is (120 × 8,760) ÷ 1,000 = 1,051 kw.-hr. At 2 cents per kw-hr. the iron-loss cost is 1,051 × 0.02 = $21.02, and, the total charge is $25.30 + $21.02 = $46.32 per year.

In the old transformer the iron loss is 270 watts. If we assume that the iron loss in the old transformer has increased 20 per cent, due to aging of the core iron, above the value in the table, then the total core loss is 270 + (270 × 0.2) = 324 watts. In one year of continuous operation this loss amounts to (324 × 8,760) ÷ 1,000 = 2,838 kw.-hr. At 2 cents per kw.-hr. this power is worth 2,838 × 0.02 = $56.76. This is greater than the fixed charges plus iron-loss cost of a new transformer, therefore according to the rule given above it will be more economical to install the new transformer. The lower copper loss gives a still further advantage to the new transformer.

If the iron-loss cost of the old transformer had been $5 less than the iron-loss cost plus fixed charges for the new transformer, then repairs up to 5 × $5 = $25 would be justified. If the cost of repairs exceeds $25, it would be more economical to junk the old transformer and install a new one.

To answer the question, "Should a transformer now in service be replaced?" consider the 25-kva. transformer in the previous problems. There are several ways of considering this problem, but the simplest is to determine how quickly the savings in iron and copper losses will pay for the new transformer. If this period is satisfactory, then the other considerations may, in general, be neglected. In the new transformer the iron loss amounts to 120 watts and in the old transformer it is 324 watts, or 324 — 120 = 204 watts in favor of the new transformer. The full-load copper losses of these transformers are 376 and 460, respectively, or 460 — 376 = 94 watts in favor of the new transformer.

Assume that the transformers operate under conditions to make the average copper loss equal to 50 per cent of full-load copper loss. Then, the saving in copper loss is 94 × 0.5 = 47 watts. The total saving is then 204 + 47 = 251 watts, or (251 × 8,760) ÷ 1,000 = 2,200 kw.-hr. per year in favor of the new transformer. At 2 cents per kw.-hr. the saving in losses is worth 2,200 × 0.02 = $44 per year and is available to pay interest on investment in the new transformer and to amortize its cost. If the transformer cost $230 and interest is charged at 6 per cent, then the saving of $44 will pay interest and amortize the cost of the new transformer in less than 6.5 years. When other factors are considered installation of the new transformer will be a good investment.

In the calculations no allowance has been made for the cost of installation of the new transformer and it has been assumed that the junk value of the old transformer will about equal this cost. No account has been taken of taxes and insurance, but taxes will be about the same on each transformer and insurance should be considerably less on the new transformer than on the old.

The new transformer should operate for 10 years or more, under normal operating conditions, with very little or no cost for repairs other than painting or minor repairs to external wiring, such as would be required by the old transformer. Internally the new transformer will probably require no attention, but the old transformer will very likely need to be taken out of service for cleaning and renewing the oil. The possibilities of the old transformer failing in service and requiring replacing or expensive repairs within the period of 6 years are many times those of the new transformer.

Modern transformers are smaller, lighter and better in appearance than old types, but their outstanding advantage, outweighing perhaps even decreased losses, is better insulation and protective features which insure continuity of service. Distribution transformers may be had with protective gaps between the leads, tank and ground so that any surge will be discharged to ground without puncturing the insulation. The gaps embody the deionizing principle, so that the power arc which tends to follow the surge is extinguished before the transformer fuse is blown. This conquers two foes of good service, punctured insulation and blown fuses, and it is a strong reason for replacing old transformers. The photo is a view looking into the top of a distribution transformer with deion gaps at *A*.

The answer to the question of replacement may be purely economic, based on losses, or this answer may be modified by the need for improved reliability. The method of evaluating the advantages of the new transformer over the old will also vary with the engineers making the estimate. For example, an industrial-plant engineer would probably follow closely the procedure outlined in the foregoing, where a central-station engineer would include loss of revenue due to poor voltage regulation of the old transformer and also other factors. Voltage regulation may interest industrial engineers because of its effects on production.

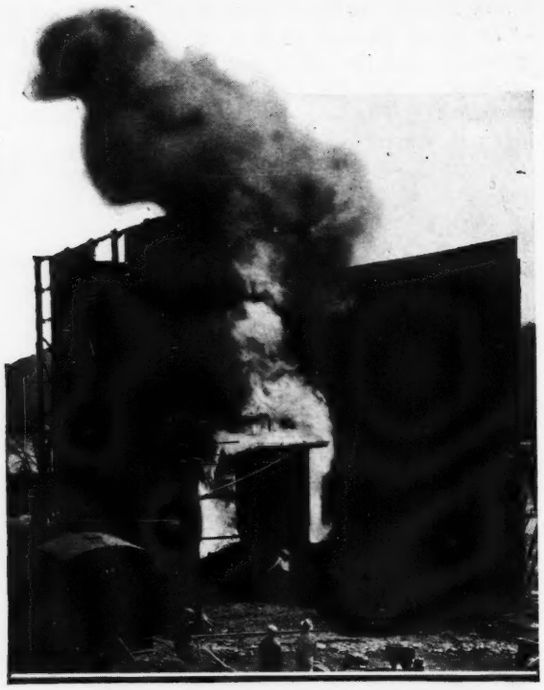
Losses in Westinghouse 2300- to 230-115-Volt Distribution Transformers From 1907 to 1933

	Up to 1907				1908–1916		1917–1926		1927–1929		1930–1932	
	[1]OD		[2]C		S		S		S		S	
Date Type Kva.	[3]Fe Loss	[4]Cu Loss	Fe Loss	Cu Loss	Fe Loss	Cu Loss	Fe Loss	Cu Loss	Fe Loss	Cu Loss	Fe Loss	Cu Loss
1.5	48	60	33	43	26	37	21	51	20	50	20	46
3	73	98	47	67	38	65	33	63	30	76	27	71
5	92	151	62	102	43	118	45	83	39	104	37	104
7.5	137	185	85	149	60	151	60	107	54	133	50	142
10	159	237	100	186	70	186	70	160	67	173	59	183
15	195	362	139	278	96	261	106	177	90	260	80	253
25	270	460	185	452	134	442	140	310	128	380	120	376
37.5	....	....	263	680	180	535	200	400	184	480	155	495
50	....	....	300	740	236	749	250	500	235	585	190	605

[1]The cores of type OD transformers are of non-silicon steel which is subject to aging, and their iron loss may increase from 10 to 30 per cent after about a year's operation.
[2]Type C transformers and type S transformers built since 1909 have non-aging silicon-steel cores. [3]Fe = iron and [4]Cu copper.

AN EXPERIENCE STORY of SAFE HARBOR PLANT—II*

By F. A. ANNETT
Associate Editor



This is not operation at Safe Harbor, but tests being made to determine the most effective way to extinguish a fire in the large high-voltage out-

SAFE HARBOR plant has been for two and a half years in successful operation and is meeting all requirements as a commercial hydro station. At the same time, it has also served as a field laboratory to check conclusions reached in the research laboratories. With these facilities, which include every step from pure research to practical commercial operation of the largest units of their kind in the world, it is hoped to establish complete data on many problems associated with cavitation in hydraulic and power engineering.

Besides the turbines, several other features of the plant's design and operation have been subjected to exhaustive research. Protecting main transformers, which are located out of doors in bays on the intake-deck level, against fire is important. The Pennsylvania Water & Power Company had for years been studying protection from transformer-oil fires. It continued these experiments in cooperation with the Safe Harbor Company and exhaustive tests were made with various suggested means of extinguishing such fires.

Conditions were duplicated, as nearly as possible, under which the most severe oil fires might happen. Then, engineers of fire-extinguishing apparatus companies were allowed to demonstrate the efficiency of their equipment. As a result of these experiments a system using water was developed that was considered to be more satisfactory than any other for Safe Harbor. The experiments should not be interpreted as in any way condemning other systems of extinguishing electrical and oil fires. An automatic carbon-dioxide system has been provided to extinguish fires in generators and oil switch galleries.

The Susquehanna River is subject to severe ice conditions, but so well were precautions taken in the layout of the Safe Harbor plant that troubles from this source have not materialized. Provisions were made for installing a mechanical rack-raking and a trash-sluicing system. The wing wall at the forebay entrance has deflected debris and ice so successfully that the racks have remained practically clean and it will not be necessary to install the cleaning system. An air-bubbling system has been provided to keep the sluice and control gates on the dam free of ice, and electric heaters are installed to keep the gates free in their guides. These have worked very well, even under the severe conditions of last winter.

When the units were installed, it was expected that certain areas of the runner blades and draft-tube liners would pit because of cavitation. In fact, cavitation limits were expected to establish the economic loading of the machines. This has worked out about as expected.

Last year it was decided that the effect of cavitation on certain of the runner blades was such that pitted areas should be welded. The engineers had been experimenting on some of the Holtwood units by welding pitted areas with various materials and reached the conclusion that stainless steel would be most successful for Safe Harbor.

The cost of welding these units was not great, compared to the gain from operating them at the higher output obtainable at the expense of slightly more severe pitting. This cost for the blades of four runners totaled $13,500, about half for labor and half for material. On May 27, I had an opportunity to inspect one of these units that had been in operation for nearly nine months since being welded. Signs of pitting were almost completely absent. Unless told otherwise, one would assume from the appearance of the welded areas that the unit

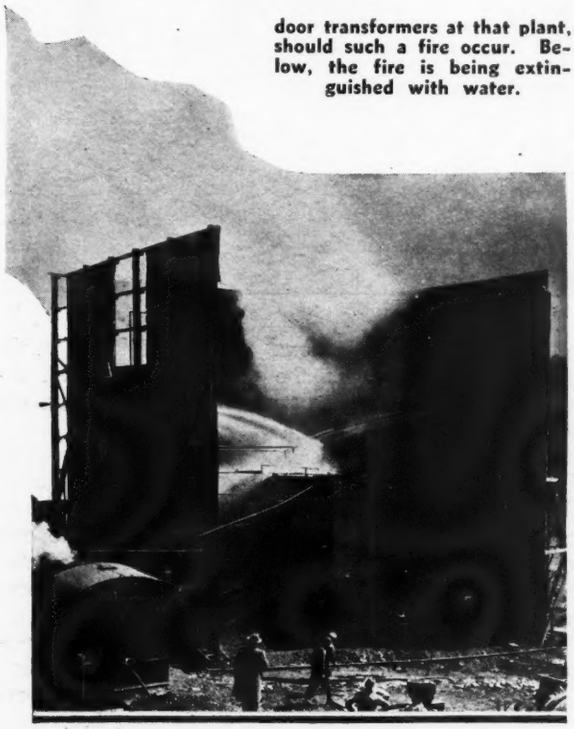
*Part I of this article, published in the July number, dealt chiefly with design and test problems. Part II treats largely of operating problems and how they have been solved.

had not been in service since completing welding and grinding. This unit had deliberately been subjected to relatively severe cavitation; its load was increased 1,000 kw. above that normally carried before being welded.

The cost of welding, to June 1 of this year, amounts to a little less than $10 per 1,000,000 kw.-hr. generated, or 0.01 mil per kw.-hr. No major welding jobs on the units are scheduled for this year. Considered in this way it is evident that the welding has been only a minor item of operating expense. *Power* plans to publish an early article explaining how this welding job was done.

Trouble was experienced with packing around the joints between the runner-blade shanks and the hub and also in the main stuffing box where the runner shaft passes through the crown plate. Both of these problems have been successfully solved. The first caused considerable leakage of oil from the hub; this has now been reduced to a very small quantity. Stuffing-box leakage allowed water to pass upward along the main shaft (the turbine shaft oscillates sidewise about 0.015 in.). The original shaft packing was not resilient enough to follow these oscillations and was soon forced clear of the shaft. After some experimenting a packing was obtained sufficiently resilient to follow the side movement of the shaft and remain tight for long periods. Some of this packing has now been in service for over 14 mo. and is still in good condition.

door transformers at that plant, should such a fire occur. Below, the fire is being extinguished with water.



In a modern hydro-electric installation similar to Safe Harbor the equipment is designed so that wear is largely confined to certain replaceable parts. Such replacements become a part of the maintenance work of the plant. Even though this work represents a relatively small portion of the total cost, effort is profitably being made to reduce these costs still further by investigation and experiment. Aside from these replacements, the plant is largely of a permanent nature, and in the absence of any unforeseen and very unlikely catastrophies, Safe Harbor should have a very long life.

Safe Harbor units operate under very severe hydraulic conditions resulting from the long draft tubes and high exit velocities. The governors are therefore called upon to perform an extremely difficult task. A method was developed whereby the oscillograph could be applied to record the variation of system frequency and gate movement on the same film. With this device it was possible to analyze carefully the action of the governors and determine how to improve their action. Several improvements in them have resulted. First a supplementary hump has been added to the standard equalizer cam to give exceptionally heavy load droop from gate corresponding to speed-no-load to zero gate. This has been found to be very effective in preventing hunting and permits the governor to resume a constant speed within ten seconds after a sudden drop of half-rated load.

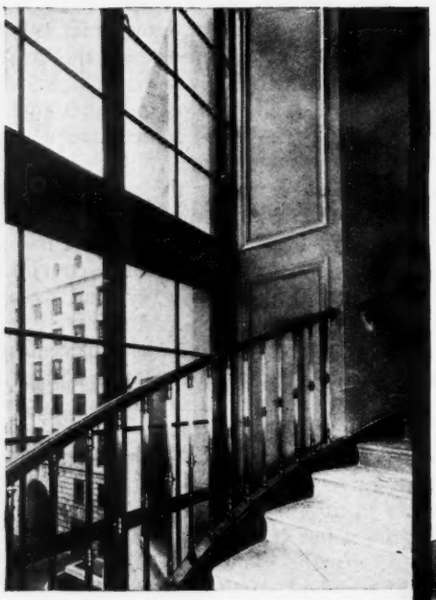
The second improvement is a special shaping of the disks of the relay valve by grinding on a slight bevel to give a graduated opening of the ports. The result is a much smoother motion of the gates when small movements are required. Furthermore by placing this bevel on the valve disk instead of on the port the lap of the valve can be varied even during operation simply by rotating the valve stem. There is always some tremble in the valve caused partly by the vibrator in the ball head and partly by slight irregularities to which the governors are sensitive. These cannot be predicted in advance and so it is desirable to be able to adjust the lap in accordance with the operating conditions.

Another improvement still in the experimental stage, is an inertia compensation, which, on sudden load changes, makes pilot valve movement a function of *rate* of speed change rather than *amount* of change. On sudden load changes, the inertia compensation acts upon the pilot valve much more quickly than the speed-change element. When the load changes slowly the pilot valve is actuated by the normal-speed change device only.

In spite of, and perhaps directly due to, all this development work the cost of the project has been kept low for an undertaking of its kind. The project includes a dam which with the power house forms a continuous structure nearly one mile long, a power house complete for seven 42,500-hp. main units and two 3,100-hp. house units and intakes and parts of the substructure provided for five additional machines, elevation of 3.76 ft. of eight miles of right-of-way for double-track, main-line railroad, and water rights on each side of the river. With six main units and two house units, 261,000 hp. installed, the cost will be about $28,000,000, or $107 per hp.

Results

The plant has more than met expectations as a power producer. With the sixth unit in operation, the pond raised 2 ft., and at 100 per cent utilization, it will produce about 900,000,000 kw.-hr. per year of average water flow. The development work in connection with this project has advanced low-head water-power engineering ten or fifteen years. Incidentally, it has paved the way for the 60,000-hp. or larger Kaplan units that the United States Government plans to install in General Joe Wheeler dam plant on the Tennessee River and in the Bonneville dam plant on the Columbia River. Without the work done at Safe Harbor the installation of such units could only be undertaken with a large element of risk that no longer exists.



CONDITIONED AIR AND HEAT

For Washington's New Post Office

By R. N. WARD
Mech. Eng., Syska & Hennessy

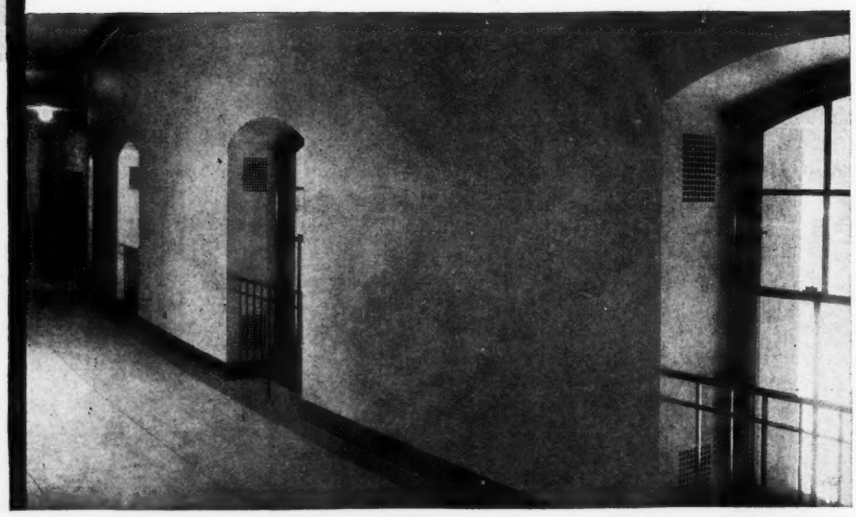


Fig. 1 (Above)—Radiant heat panels at right of windows heat this stairway. Fig. 2—Vertical radiators solved this heating problem

Three systems distribute conditioned air; four methods are used to supply heat

UNUSUAL construction and architectural requirements made it necessary to provide three types of distribution systems for air-conditioning the new Post Office Department Building, Washington, D. C. The most extensive method of distribution consists of five high-pressure systems. These supply cooled and dehumidified air to the greater portion of the building, used as general office space. The second method, known as the booster fan system, is used to serve the Postmaster General's Office and the adjoining reception room. The third method utilizes a single conventional by-pass apparatus to furnish conditioned air to a basement cafeteria.

The high-pressure systems are supplied with conditioned air from five dehumidifiers on the eighth floor of the building. After leaving the dehumidifiers at 50 deg., the nearly saturated air is forced through a horizontal duct in the attic space. Connected to this main duct are a series of down-feed sheet-metal risers. These risers, near columns at exterior walls, connect with short horizontal runouts which convey the air to room-conditioning units under windows or built into exterior walls on the various floors.

All room-conditioning units consist of a plenum chamber, a heating element and a series of adjustable nozzles, all within a sheet metal casing which is provided with a supply grille at the top and a return grille in the front near the bottom. Two small knobs in the top of the unit permit the occupant to control the amount of conditioned air or heat supplied the enclosure.

The conditioned air, as it is discharged vertically at high velocity from the nozzles, produces an ejector effect which results in considerable local recirculation and movement of the room air. During winter operation when heating is required, air movement is created through the return grille by the stack effect produced by the heating element.

• Supplying conditioned air from individual room-conditioning units possesses several advantages. First, it makes possible installation of small ducts and requires smaller shaft areas than could have been used with other methods of air distribution. Second, it permits the individual to adjust temperature conditions within any enclosure to suit his particular desire.

A portion of the air supplied by each high-pressure fan is returned and reconditioned. Return air is withdrawn from the various office spaces on each floor through a louvred opening in the lower half of each corridor door. This air is then circulated through the corridor to a return air grille which connects with one of five return air shafts. This permits all corridors to be ventilated.

During regular operation, equal volumes of return

and fresh air pass through the air washer. However, it may be desirable, during periods of low relative humidity, to use a greater portion of outside air to take advantage of the refrigerating effect created by evaporative cooling. To accomplish this, large manually operated louvred dampers are provided in both the return air and fresh air ducts in the apparatus rooms. These permit the amount of fresh air admitted to the system to be varied in order to gain greatest operating economy.

For winter operation, extended fin-surface heating stacks in the fresh-air intake chambers temper the air and furnish the heat required to increase humidity. Reheating stacks in the fan intake chambers reheat all air during extremely cold weather before it is delivered to room-conditioning units.

Architectural treatment of the Postmaster General's office and reception room did not permit installing conditioning units under the windows. In these rooms, high casement windows extend close to the floor, making it necessary to introduce conditioned air with booster fans through outlets on interior walls. A portion of the air so supplied is recirculated through a concealed return air duct.

Each booster-fan system consists of a circulating fan, air filter, extended fin-type booster heater and distributing duct. Primary air at 55 deg. is supplied by the high-pressure system and mixed by the fan with a portion of recirculated air before discharge into the conditioned enclosure through specially designed grilles at each side of the room. Desired room temperature is maintained by governing the position of automatic mixing dampers in the primary and return air ducts operated by a pneumatic damper motor controlled from a room thermostat.

The cafeteria system will be operated for only a short period during each day. Fresh air for this system is taken from a basement areaway and passes through an air filter before being conditioned in the dehumidifier. After passing through the dehumidifier spray chamber, this air is mixed with an equal volume of recirculated air which is by-passed around the dehumidifier, and delivered by the fan to the dining room through specially designed combination lighting and air ceiling outlets. Dining-room conditions of not over 80 deg. F. and 50 per cent relative humidity are maintained during the summer by an automatic by-pass damper actuated from a duct-type thermostat in the return air duct.

Steam Distribution System

All steam used in the building is supplied from the government's new heating plant, described on page 373 of the July number. Space, however, has been provided in the basement for the installation of six 2,600-sq.ft., 100-lb. pressure oil-fired boilers.

Steam enters the building through an 8-in. service main at approximately 200 lb. pressure and is reduced to 100 lb. in passing through one of three service regulators connected in parallel. Arrangement of the regulators in this manner was considered necessary to take care of wide ranges of steam demand.

After passing through the regulators, the steam is metered and fed to a 12-in. main steam header at one end of the future boiler room. After leaving the main steam header at 100 lb., steam pressure is further reduced to that required for the several services, such as heating, kitchen service, hot water heating, hospital sterilization, air tempering and the like.

All condensate is collected in returns and discharged to a common return tank. From the common return tank, it is pumped back to the new central heating plant by one of two centrifugal condensate pumps, one turbine- and the other motor-driven.

The single-stage turbine driving the one pump is designed to operate with saturated steam at 75 lb. pressure exhausting at 5 lb. back pressure. Exhaust steam from the turbine is discharged into the low-pressure steam heating main in the attic.

To provide for flexible control of steam to various parts of the building in accordance with demands and the complicated conditions imposed by architectural design, the heating system is sectionalized into seven zones. One zone includes certain radiators on the first and second floors around the 13th Street side circle which are fed through an up-feed system of risers. All remaining zones are supplied from steam mains in the attic by down-feed systems. The relative locations of the zones served by the down-feed systems are shown in Fig. 3.

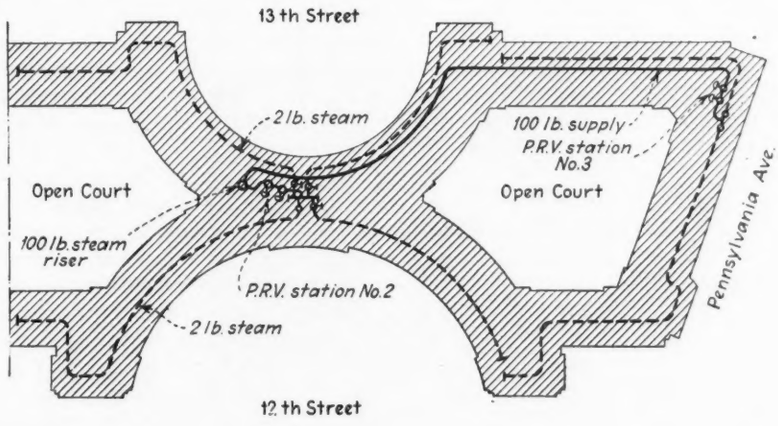


Fig. 3—Steam distribution piping in attic space

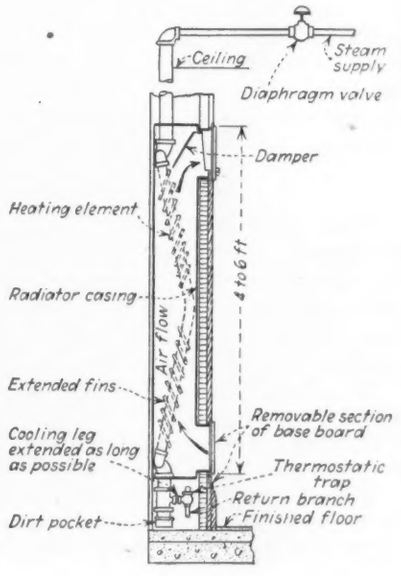


Fig. 4 — Section through vertical radiator

All return mains are drained of condensate by six duplex-type vacuum heating pumps which discharge to the common return tank. Four of these pumps have a rating of 40,000 sq.ft. each, and two have a rating of 26,000 sq.ft. each and are capable of maintaining a vacuum of 10 in. on the return line.

Steam for heating is reduced at three reducing-valve stations. One station is in the future boiler room and reduces the pressure for all radiation connected to the up-feed system. Two other stations in the attic, and indicated in Fig. 3, reduce steam pressure for all radiation connected to the down-feed system. All steam used for tempering air and heating hot water is reduced in the various basement mechanical equipment rooms in which the service is to be used. Steam for air tempering and reheating in the attic equipment is taken directly from the low-pressure main because structural conditions did not permit running separate high-pressure lines to each equipment room. All medium-pressure steam is reduced at one station in the future boiler room.

Steam required for heating is reduced from 100 lb. to approximately 2 lb. in two steps. The first step reduces the pressure to approximately 20 lb., the second reduction to 2 lb. Steam required for basement heating stacks is reduced in one step to 5 lb. pressure, for heating hot water the pressure is reduced in one step to 20 lb., and for medium-pressure service the steam is reduced in one step to 40 lb. pressure.

Pressure reducing valves used for all services are of the single-seated auxiliary-operated type with a metal diaphragm and piston-operated main valve. At every point of steam reduction by-passes are provided. A steam strainer and gage are installed on the high-pressure side of all valves, and a gage and relief valve are installed on the outlet side of every valve except primary reducing valves.

Due to the architectural treatment of various rooms, heat is supplied by four different methods: direct radiation, which includes both cast iron and copper fin surface, hot-blast indirect heating, enclosed vertical radiation and radiant heat radiators.

Cast-iron radiation is used in all utility rooms, corridors and certain entrance lobbies. Direct radiation of the extended copper fin flue type is used in all general office spaces, the radiators being an integral part of the room-conditioning unit. Hot-blast indirect heating is used exclusively in certain lobbies, and both direct cast-iron and hot-blast systems are used for heating the cafeteria dining room. The indirect heating surfaces for the dining room are part of the air-conditioning equipment and are in the bypass of the dehumidifiers.

Radiant Heat for Stairway

Two circular stairways in the central part of the building are heated by radiant-heat radiators. These are indicated in Fig. 1, which shows the structural conditions involved. With the exception of the narrow spandrels at each floor level, the glass surface shown extends from the first to the eighth floor.

The radiant heat radiators consist of $\frac{3}{16}$-in. steel plates to which are attached a series of 1-in. vertical steel tubes. The tubes are connected at top and bottom into steam and return headers.

To accomplish the desired heating effect throughout the entire height of the stairway and to eliminate down drafts and stack effect, each radiator or heat panel is automatically controlled from its individual thermostat on a similar panelled plaster wall directly opposite.

Vertical Radiation Used

A split system of heating is used for the Postmaster General's office and reception room, but in both these spaces it was necessary to augment the heating coil installed in the air-conditioning booster-fan system with an enclosed vertical extended-fin radiator in the reveal of certain windows to preserve treatment of the rooms. Fig. 4 shows this type of radiation. Access is gained to the diaphragm valves and traps through a removable base-board section or through false wall panels.

The architectural treatment required by certain casement windows on the second floor curved corridor also required the use of vertical radiators. Fig. 2 illustrates clearly the supply and return grilles of the unit installed in the window reveal.

Temperatures are controlled in all conditioned office spaces by self-contained thermostatic valves. The bulb of each valve is concealed behind the return air grille of the air-conditioning unit.

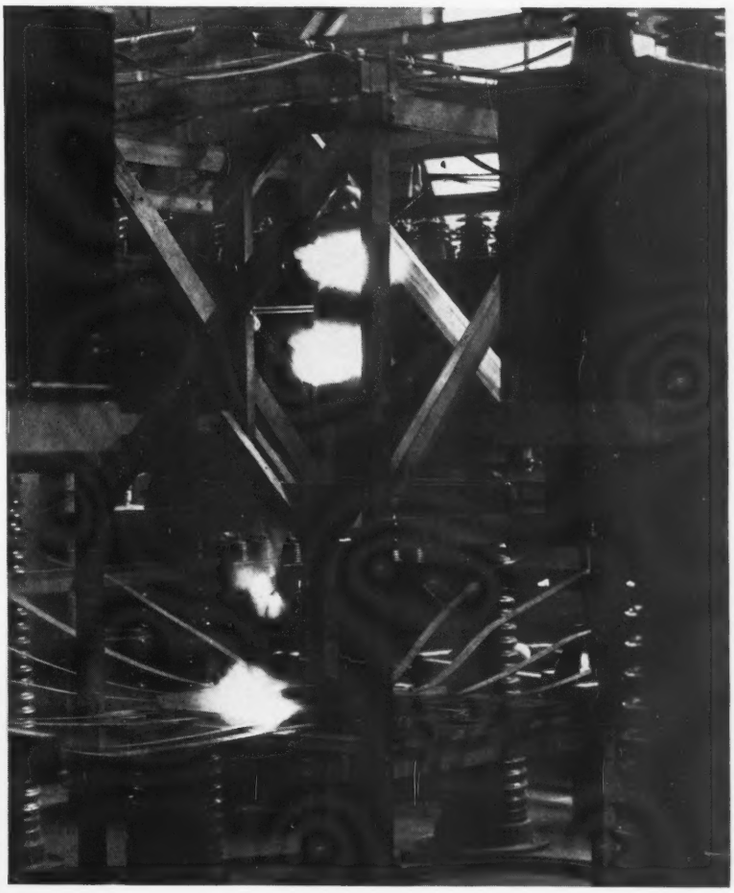
An additional pneumatic temperature-control system is provided in connection with other equipment, including all radiators in the dining room of the cafeteria, concealed radiators in entrance lobbies and all tempering and pre-heating stacks used in connection with the air-conditioning and ventilating systems. Compressed air is supplied for the pneumatic temperature-control system by two 7x7-in. horizontal air compressors. These compressors deliver air at 100 lb. pressure to various mechanical equipment rooms where it is reduced to 15 lb. pressure for use in operating diaphragm valves and damper motors.

The large number of pumps, fans, motors and other equipment so widely separated throughout the building would have made it practically impossible to operate the air-conditioning system unless a signal and alarm system was installed. For this reason an elaborate signal system has been provided for certain fans, pumps and motors. One feature of the signal system is a green and red pilot light provided for each motor and located on a control board in the compressor room. The stopping of any fan or pump motor promptly notifies the operating engineer by the automatic flashing of the red pilot light. As additional warning an electric gong, wired into the pilot-light circuit, continues to sound in the event of any motor failure until the engineer recognizes and attends to the equipment that has failed. A second system of gongs warns the operator of abnormal conditions in the equipment in the refrigerating room.

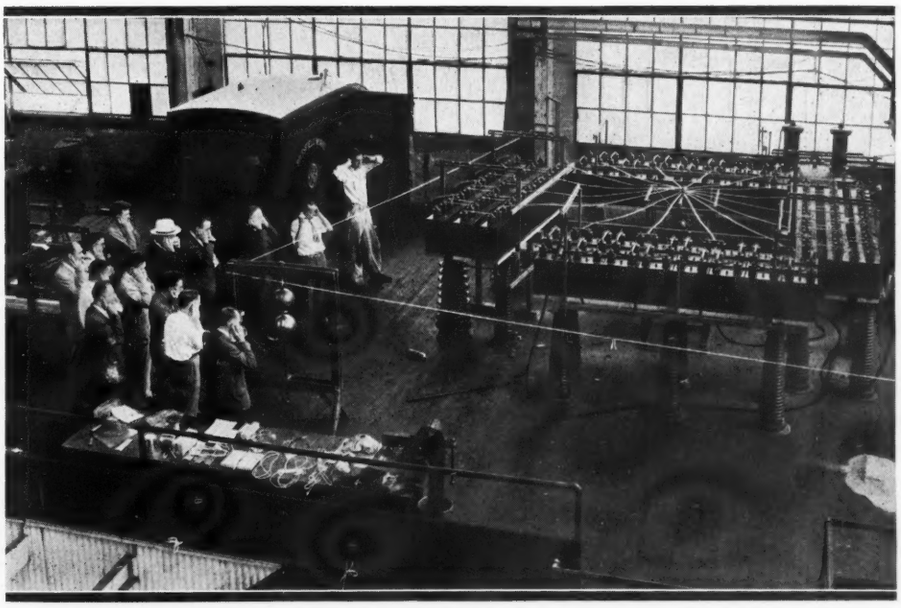
Installed on a second control board in the chief engineer's office are additional steam pressure gages and various flush-mounted multi-point strip-chart type temperature recorders, which record air and water temperatures entering and leaving all inter-changers. A continuous record is also made of the existing outdoor dry and wet bulb temperatures. An indicating integrating and recording steam flow meter is also part of the recording equipment on this control board.

Delano & Alrich, New York architects, are responsible for design of the building. Mechanical equipment was designed by Syska & Hennessy, New York. All air-conditioning and refrigeration was installed by Mehring & Hanson, Chicago, and the heating, ventilating and piping was installed by Jarcho Bros.

QUARTER MILLION AMPERES



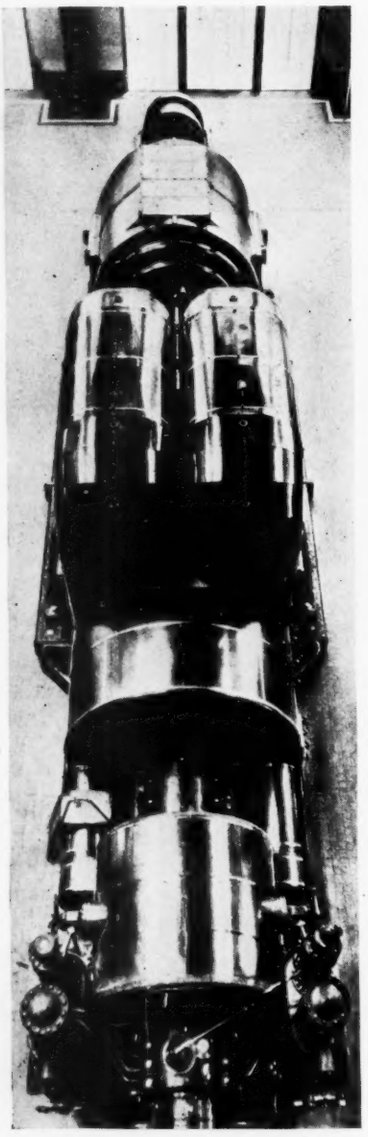
FAR greater than any ever produced by man or by direct lightning strokes so far recorded, currents of a quarter million amperes at 150,000 volts are being utilized by K. B. McEachron and his staff in the General Electric high-voltage laboratory at Pittsfield, Mass. They are studying ways and means to protect electric and other equipment against lightning. The apparatus includes 96 Pyranol-filled capacitors, arranged in a hollow square 88 in. across inside, coupled in series-parallel and charged with ordinary 110-volt current.



FIFTY YEARS

The past, present and future of power generation, as seen by leading American engineers

The June number marked Power's *fiftieth anniversary. Further to commemorate a half-century of progress, the editor invited a number of engineers to send him their thoughts on the past, present or future of power generation. Four pages of these letters were published in the July number. Here are others, equally interesting, some describing the rough-and-ready operation of early days, others looking to the future. Additional letters will be published in the September and October numbers of* Power.



Since 1888

• I NOTE with extreme interest that *Power* has reached its fiftieth birthday, and It must be the source of a great deal of pleasure to yourself and to those "old timers" to whom *Power* as a mechanical and engineering guide has meant so much in the years now past, and especially to those directly associated with its production during all these years. As I look back upon the past fifty years the revelations, improvements, and changes that have taken place seem almost unbelievable.

I was nineteen years of age in 1887 when through the influence and assistance of the then chief engineer of The New York Tribune Building, James A. Stillman, I obtained a position as machinist's helper in the composing room of *The Tribune*. They had been experimenting with eight or ten of the first Mergenthaler linotype machines that had proven reasonably successful.

In the meantime Mergenthaler had moved to Brooklyn and I accepted a position with them to take charge of their machine operation and teach their operators. At the same time I was called upon to test the operation of any new machine before it was shipped out. I held this position until November, 1888, when Mr. Stillman of *The Tribune* came over to see me and offered me the position of engineer's helper, which I accepted.

From that point on I devoted all my time and energy to learn the engineering profession, and it was about that time that I began to subscribe to *Power*. In my judgment it was one of the greatest friends and instructors that a younger engineer could have, for the reason that it made a specialty of isolated power-plant operation. I shall never forget the many interesting things published in that paper.

When I joined *The Tribune* we had two 50 kw. bi-polar Thompson-Houston dynamos, one belted directly to a New York Safety Steam Company's engine, and one belted directly to a countershaft driven by a pair of Corliss engines which also drove the presses in the cellar and a cable drive going up the outside of the building to the 9th floor, connecting to the shaft driving the linoypte machines. These two generators in the Tribune Building were considered at that time one of the show installations of electrical equipment in the city.

In those days also the engineers had to know their engines, be their own oilers, electricians, and steamfitters and boiler cleaners, and the old *Power* carried many a story covering all these fields.

Space would not permit listing all of the great improvements that have blessed the world since that period, but I cannot help but wish once in a while that I were about thirty-five years younger and were associated with some of the younger and larger developments of engineering that have taken place in the past few years. Think what the future holds for those now in their young manhood! Please accept my sincere congratulations on *Power's* attainment of its fiftieth birthday.

A. S. VINCENT.
Chief Engineer.
Federal Reserve Bank of New York.

Inspirations

• WHILE *Power*, with its recent Fiftieth Anniversary Number, surveys the field as a veteran of half a century, I personally can go back nearly half as far to the time when I first consciously met power, the intangible "substance," and *Power*, the highly tangible magazine. (My oldest book, I believe, is F. R. Low's "Condensers"—a reprint from the columns of *Power*, dated 1907.)

In spanning this time, the influence of five thoughts or impressions stand out quite a little above all others:

First: Carnot's second law of thermodynamics—particularly as stated in the elegant language of Pupin.

Second: Lord Kelvin's law of economical size.

Third: Steinmetz', "The future of electricity lies in the vacuum tube."

Fourth: Fred Low's, "Power cheap as tap water at the kitchen sink."

Fifth: Fred Low's, "Blowing down a boiler through the steam nozzle."

I do not know how it is with other power engineers, but to me each of these thoughts brings a peculiar thrill I find in few other things. As I look back they seem to be old friends—good Samaritans—I met along the road. As I look ahead, by some peculiar mirage, they seem to belong to the future as well as to the past. They thus seem to meet the acid test of durability because they are largely independent of time.

Carnot drew his "Second Law" from the vitals of the universe, and it took us, collectively speaking, a hundred years to understand him in a practical sort of way. I am not at all sure, however strong and eager and confident we may be about the future, that it will not be at least another hundred years before society appreciates the full significance of Fred Low's homely analogy on the price of power. I am not at all a pessimist, like H. G. Wells (for a world-famous example), yet there surely seems to be a serious time lag in the affairs of man which is very definitely a function of mass stupidity. So I often wonder how it is, after all, that we do progress and whether there ever will be developed such a thing as a science of progress. We still build towers of Babel or "each in his separate star paints the thing as he sees it for the God of things as they are" (to give a reverse twist to a famous poem). So we need now—as in the past and in the future—the unifying and broadening influence of great teachers. Fred Low as editor of *Power* for so many years was such a teacher. To me his name and that of *Power* are synonyms. Both deserve our sincere commendations and best wishes for another fifty years.

GUY B. RANDALL,
Power Engineer,
Champion Coated Paper Co.

POWER'S Early Days

• FIFTY-ODD years ago I was writing and soliciting for a little "scheme paper" called the *Buffalo Journal of Commerce.* I went one day into an office at Lockport, N. Y., after business. The manager brought out a copy of the *Boston Journal of Commerce* with the remark, "This is the Journal of Commerce for you."

I knew nothing about papers, but was so impressed that I went back to my hotel and wrote an application for a position on the *Boston Journal of Commerce* and got it. An interesting thing about my getting that position was that it was ultimately the means of bringing perhaps a dozen men from Chautauqua County, where I lived, to embark in the trade publishing business. The first of these men was Horace M. Swetland of Mayville, N. Y., a country school teacher for whom I got a job with the *Boston Journal of Commerce.* Mr. Swetland was to become chief of the early builders of *Power.*

The *Boston Journal of Commerce* blanketed a number of fields and had the weaknesses of the "omnibus" paper. Thomas Pray, Jr., the editor, was interested in steam, textiles and machine tools and wrote and secured matter along these lines.

Mr. Swetland and I, and two other reporter-solicitors, each had a territory to cover in which we were supposed to know what was going on at the bottom of every tall smoke-stack, to write it up for the paper and get all the subscriptions and advertising possible.

The disadvantage of the omnibus paper to the subscriber of course was that, while he paid three dollars a year for his paper, he got very little of interest to him, and his attention was distracted by a mass of to him uninteresting stuff which really diluted the stuff he wanted. And to the advertiser the disadvantage was still greater, as he would be charged for space a price based upon the whole circulation of the paper, of which only a small portion was of value to him.

Discussion of these weaknesses by Mr. Swetland and myself suggested and confirmed the idea of *Power,* a paper wholly for power readers and advertisers of power appliances.

Later, after I had withdrawn from the *Journal of Commerce,* I bought a controlling interest in the American Railway Publishing Company of New York, publishers of the *American Journal of Railway Appliances.* This paper was edited by Robert Grimshaw, a trained engineer capable of editing a power-plant magazine.

Such a paper we proceeded to plant. The first issue was a small, thin paper devoted largely to telling what it proposed to do and be. Before the second number was issued, we bought a small Chicago paper called *Steam* and devoted largely to promoting the interests of the National Association of Steam Engineers (N.A.S.E.). This paper, largely fraternal, was put out by a Mr. Hawkins, who used the pen name of Theodore Audel. This paper we merged with *Power.*

Power set out to discuss comprehensively, but in language adapted to the head of the establishment or to the engineer, all that related to the efficient and economical generation and transmission of power for stationary purposes.

The paper was favorably received from the start by both readers and advertisers. Mr. Swetland was brought in as manager, and for some twenty years was close to the paper and important to its development. Mr. Swetland became part owner in the company and brought in James H. McGraw, who also bought an interest in the company. Messrs. Swetland and McGraw and the writer successfully operated the American Railway Publishing Company, launching another new paper, the *Street Railway Journal,* for which the development of street railways called at the time, though electric power had not yet been applied. Later on Mr. Swetland and Mr. McGraw sold their interests in the company to me and each bought a paper of his own. Mr. Swetland bought *Power* and Mr. McGraw the *Street Railway Journal,* which is still published (now as *Transit Journal*) by his company.

Perhaps no other paper ever more forcibly illustrated the merits of the single-line paper than does *Power.* Mr. Swetland and I, who may be said to have been with the paper since it was only a dream, have been greatly gratified by the paper's success.

EMERSON P. HARRIS.

The Next Fifty Years

• CONGRATULATIONS on the fiftieth anniversary of *Power,* a magazine which has had an outstanding part in bringing to the highest levels of attainment that phase of modern civilization in which human effort is lightened by power.

Over thirty years ago, as a professor of mechanical engineering at the University of Montana, I first became intimately acquainted with the fascinating appeal of your magazine, and now for thirty years I have been a consistent reader.

As I see it, new and hitherto undreamed of applications of energy will in the next twenty-five years carry civilization on to higher and more satisfying levels of attainment. To see that these applications of energy serve the human race in such a manner that they do not become the master of the race, and at the same time to see that the individual himself will have his individual rights protected, is I think, the destiny of *Power* in its leadership of tomorrow.

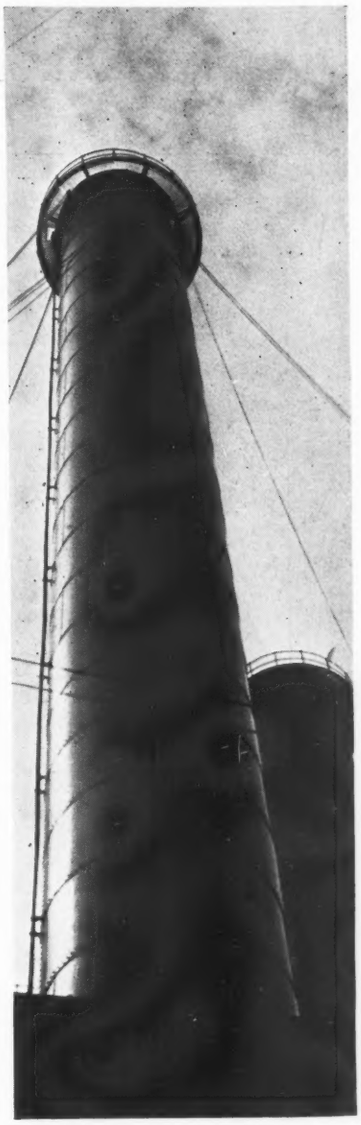
ROBERT SIBLEY,
Consulting Engineer,
Berkeley, Calif.

"Fool Ideas" That Worked

• I AM reminded of the tendency among power engineers to think that today's practice is fairly standardized and eminently satisfactory. This usually leads to a belief that innovations are not worth a great deal of attention. A familiarity with history of engineering would undoubtedly have facilitated the development of practices now well established and have greatly reduced the arguments. In the old days the lovers of reciprocating engines made a great deal of sport of the then-new turbine. Time has proved them wrong.

I often look at the picture of Hero's original turbine, consisting of a sphere mounted on trunnions. This was perhaps 2,000 years ago and that idea was long in developing into what is now our most desirable and universal form of prime mover.

All of which leads to the observation



that not much is fixed and stable in this engineering world and that investments should be amortized with the full knowledge that, as a whole, new progress is constantly throwing out present-day construction and equipment to be replaced with the new and more efficient.

ALFRED IDDLES,
United Engineers & Constructors, Inc.

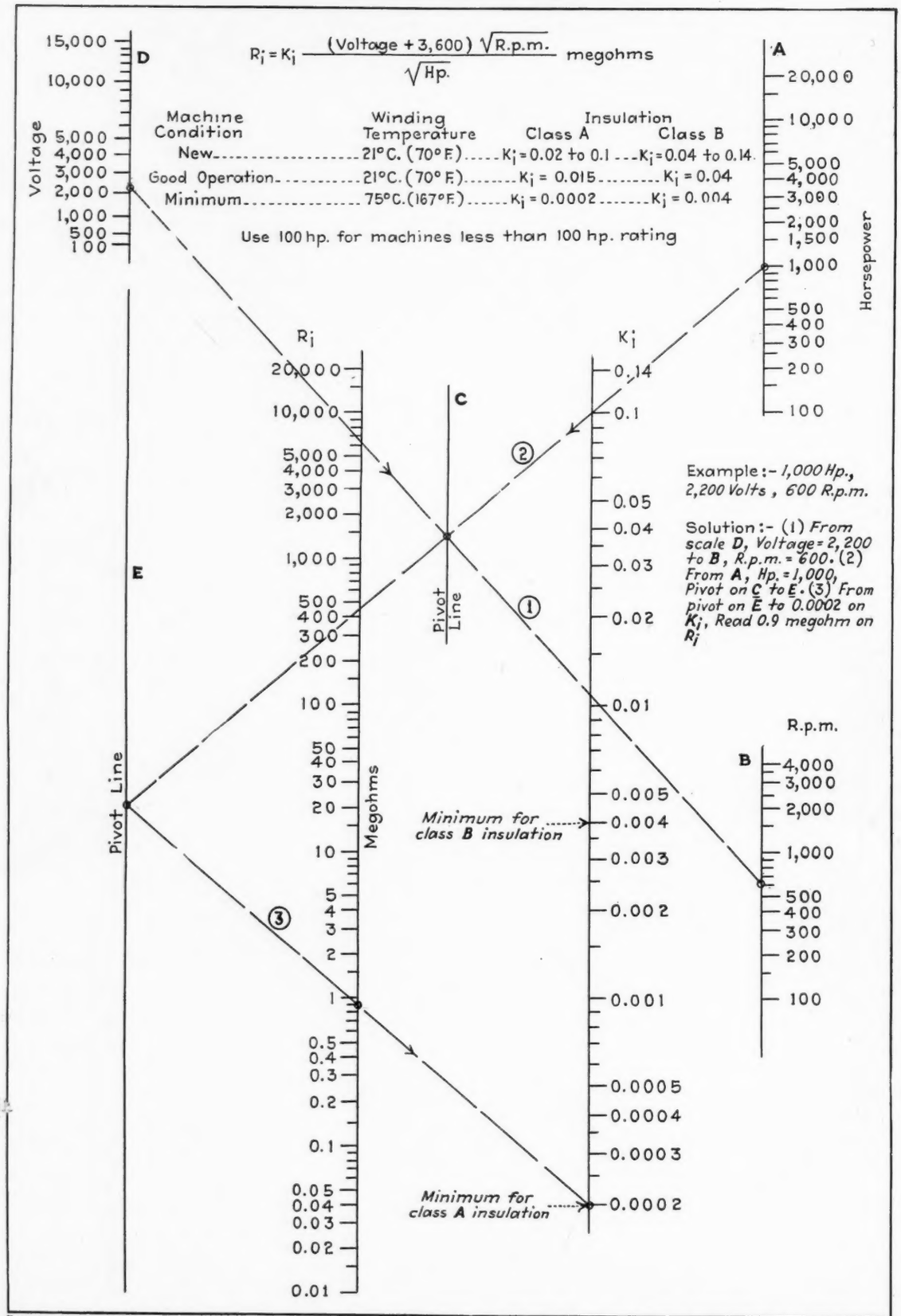
From Dean Greene

• I HAVE followed the progress of *Power* for forty-five of your fifty years and have noted its growth from a paper which appealed mostly to the operating engineer to its present form which has its appeal not only to the operator but to the designer and owner of various forms of power plants. All of your departments have been worthwhile to the teacher as well as to the man in practice, and I extend my warmest greetings for a continuation of such a useful and inspiring publication as *Power.*

ARTHUR M. GREENE, JR.,
Dean of Engineering,
Princeton University.

Number 23

INSULATION RESISTANCE FOR STATOR WINDINGS OF INDUCTION MOTORS



By Robert W. Wieseman, Designing Engineer, General Electric Co. (A.I.E.E. Journal, June, 1934)

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CHART SHOWS SAFE VALUES FOR INSULATION RESISTANCE

INSULATION resistance will probably receive very intensive study by various interests during the next few years, for the purpose of establishing a new standard. As a preliminary to this, there was presented at the summer convention of the American Institute of Electrical Engineers a paper, "Insulation Resistance of Armature Windings," by Robert W. Wieseman, designing engineer, General Electric Co. This paper gives formulas and charts that take fuller cognizance of variables than either the A.I.E.E. standard rule (that the minimum insulation resistance in megohms of a machine at 75-deg. C. should not be less than *Rated Voltage* $\div$ (*Rated Kva.* $+$ 1,000), the American Standards Association proposed revised standard, *Rated Voltage* $\div \left(\frac{\text{Rated Kva.}}{100} + 1{,}000\right)$, or any of the other arbitrary rules used (such as $3E \div Kva.$; $E \div 1{,}000$), and simply the insulation of any machine should not be less than one megohm.

The object of the paper is to describe insulation resistance characteristics of armature windings and to devise formulas for armature winding insulation resistance that take into account:

1. The speed of the machine as well as its capacity and voltage.
2. The different types of machines, such as synchronous, induction, and direct current.
3. The kind of coil insulation (Class A or Class B).
4. Coefficients that will give an average value of the insulation resistance when a machine is new; when a machine has had favorable operating conditions (clean and dry), and the minimum insulation resistance which indicates when a winding should be carefully inspected and reconditioned, if necessary.

A reading of Mr. Wieseman's paper shows that the values obtained from average insulation-resistance measurements are not very enlightening. This is not a condemnation of devices used to make insulation-resistance measurements. The trouble is in the way they are applied, and this frequently makes their reading of little value.

For example, insulation resistance at 70 deg. F. may be ten times that obtained at 167 deg. F. On the other hand, an insulation reading made with 500 volts after a 5-min application may be ten times that when the test is made for only 0.5 min. As Mr. Wieseman points out, armature-winding insulation resistance varies over a rather wide range, and experience in obtaining insulation resistances on windings indicates that:

1. A single value of insulation resistance taken at random, without knowing the kind of insulation, its construction, and a "bench mark" value for comparison, has little significance.
2. Insulation resistance varies inversely with the amount of moisture in the insulation and the amount of solvent left in the bonding varnish of the coil.
3. Insulation resistance varies inversely with temperature. If the winding is clean and dry, its insulation resistance at room temperature, 70 deg. F., may be ten or more times its value at 167 deg. F. Class A insulation varies much more with temperature than does Class B.
4. Insulation resistance varies with the time of voltage application; usually it increases during the first ten minutes of the application.
5. Duplicate machines built at the same time, and under the same manufacturing conditions may have different insulation resistance.
6. A high value of insulation resistance does not necessarily give assurance that the insulation is in good condition and free from cracks, etc., which eventually may cause a failure.
7. A machine that has a relatively low insulation resistance may have sufficient dielectric strength to operate satisfactorily for a long time.
8. Machines having the same rating, but different types of insulation, have different insulation resistances. For example, varnish fabric insulation will absorb more moisture than vacuum-dried compound-filled mica insulation.

Notwithstanding all these somewhat complicated variations, insulation resistance will indicate to a certain extent when a winding is in satisfactory condition for service or for a reasonable high-potential test. This is true if the insulation resistance of a winding can be compared with its resistance when it was known to be in good condition.

Because insulation resistance increases for some time after voltage is applied to the machine and on the basis of tests made on many machines of different types, Mr. Wieseman recommends that insulation resistance readings of a machine should be taken after an application of 500 volts direct current for one minute. In other words, if a megohm meter is used to make the insulation test, it should be of the 500-volt class and should be applied for one minute before taking the reading. The winding temperature always should be recorded, and readings should be taken at regular intervals. The trend or slope of the insulation-resistance curve will indicate the condition of the insulation better than insulation-resistance values themselves.

Five charts for different classes of machines are given by Mr. Wieseman for checking up on insulation. The one for induction motors is presented on the opposite page, and others will be published later. These charts are not complicated and provide a simple means of getting a better understanding of the condition of the insulation of a machine by measuring its insulation resistance. They give minimum insulation-resistance readings for three machine conditions: New, good condition and minimum, as indicated in the left-hand column at the top of the chart. Two of these conditions are given at winding temperatures of 21 deg. C. (70 deg. F.) and 75 deg. C. (167 deg. F.). Formula constants are given for the three conditions and for two classes of insulation: Class A, cotton, silk, paper and similar materials; Class B, mica, asbestos and other materials capable of resisting high temperature.

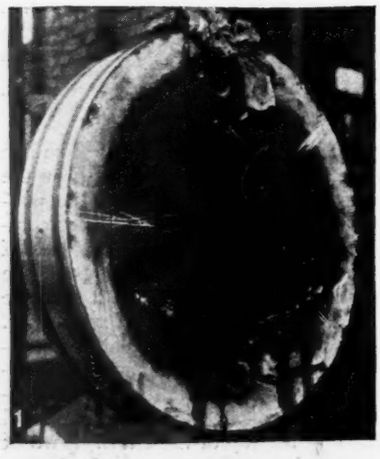
The problem given is for a 1,000-hp., 2,220-volt, 600-r.p.m induction motor. The motor has Class A insulation on its windings, constant K_i for minimum insulation resistance is 0.0002. To solve for safe minimum value of insulation resistance at 167 deg. F., draw a line from voltage 2,200 to speed, 600 r.p.m. Through intersection of this line with pivot line C draw a second line from horsepower 1,000 to pivot line E. Connect this intersection with minimum Class A insulation K_i 0.0002, as shown, and insulation resistance line R_i is intersected at 0.9 megohms. This is the minimum insulation resistance for this machine when at an operating temperature of 167 deg. F. If the machine is at room temperature, the safe insulation resistance should be several times this value.

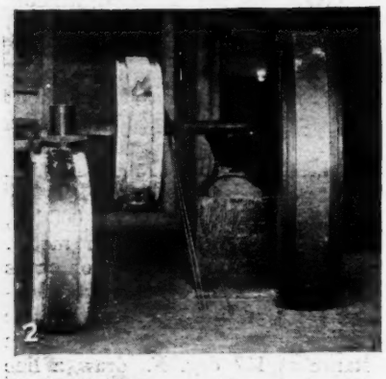
To find what the insulation resistance of the machine should be for Class A insulation, if in good condition, at 70 deg. F., use constant $K_i = 0.015$ and connect it with the intersection on pivot line E and read on R_i line 65 megohms. For a new machine of this class use constant K_i of at least 0.02, which gives an insulation resistance of 90 megohms, and may range up to 450 megohms for constant K_i of 0.1. The same process applies for Class B insulation, but use the constants K_i given under Class B.

BRONZE SURFACING

IN POWER PLANT MAINTENANCE

By T. W. GREENE
Engineering Dept., Linde Air Products Company





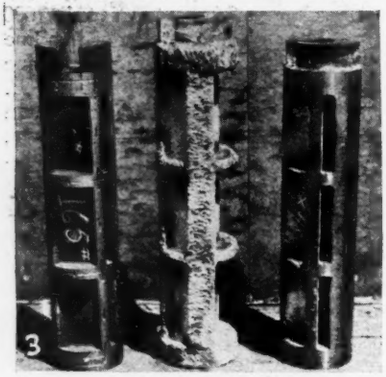


Fig. 1—Large hollow-head cast iron piston again ready for service after being bronze-surfaced. Fig. 2—Pistons in various stages of re-surfacing. Fig. 3—Rotary exhaust valves on steam engine. Right to left: Worn valve, re-surfaced valve, rebuilt and machined valve. Fig. 4—Four stages in the reclaiming of vacuum-pump valve-guard spindles.

BRONZE-SURFACING worn pistons and other sliding parts has been standard practice in more than one industrial field for some time, and has been eminently successful wherever undertaken. Yet there are many fields where it is practically unknown, but where its application would be extremely profitable.

Introduction of a special welding rod has already done much to further this type of repair. The inherent wear-resisting properties of this rod, and the ease and economy of its application with the oxy-acetylene blowpipe, make it ideal for rebuilding worn parts and for surfacing new equipment to give it longer life. Results already obtained command the attention of all industries where power equipment is in use.

The Re-Surfacing Operation

The special all-purpose, wear-resisting, bronze-welding rod just mentioned consists of an "alpha-beta" brass base possessing high tensile strength and ductility. Distributed uniformly throughout this matrix is a third or "delta" constituent, formed by the simultaneous presence of certain amounts of iron and tin, and consisting of innumerable small particles which are considerably harder than the surrounding metal and act as bearing points to support the load, thus saving the rest of the alloy from excessive wear. The additional presence of small quantities of manganese and silicon practically eliminates oxidation and gas inclusion during welding, thus giving the deposited metal great freedom from porosity and blowholes, and consequent increased strength and toughness.

Important Precaution: If the work is to be done on a hollow piston head, the core plugs should be removed or a hole drilled into the cavities before welding in order to prevent the trapped gases from expanding and bursting the piston head.

Some attention should be paid to the surface to which the bronze is to be applied. If new, or but slightly worn, the surface should be machined or ground down sufficiently so that a layer of bronze can be applied. This need not be a deep cut, as the operator can limit the thickness of the bronze layer to $\frac{1}{8}$ in. or less, and if the bronze has been properly bonded, it can be machined down later to almost infinitesimal thinness. It is well to rough-turn badly worn pistons just enough to make sure they are truly round and to assure the removal of any impregnated oil. Preheating of the entire casting is not necessary, but may be advantageous for complicated or large castings, to conserve the welding gases. The chill of the metal should be removed, however, simply by applying the blowpipe to the area to be treated.

Proper flame adjustment must be used if high physical properties are to be secured in the deposited metal. Any trace of excess acetylene causes porosity and poor bonding. A neutral flame has been found satisfactory in a number of cases, but a slightly oxidizing flame is most reliable, as this produces consistently better adhesion between weld and base metal and uniformly higher strength and ductility. The correct oxidizing flame may be obtained by adjusting to neutral and then closing the acetylene valve on the blowpipe slowly until the inner cone has been reduced in length by about one-tenth. This adjustment should be checked periodically.

Atmospheric oxygen on the heated base metal causes formation of zinc oxide ahead of the welding zone, and other oxides are formed during welding. Excessive amounts of any of these would greatly interfere with re-

surfacing. Consequently, the use of a high-quality bronze-welding flux to insure the dissolving of all oxides is essential. A liberal amount of flux should be added continuously, and this can most easily be done by heating the welding rod and rolling it in flux spread in a long horizontal container, as this flux adheres readily to a heated rod.

Proper tinning, the secret of a strong bond between base metal and bronze, will be assured if the base metal is heated just sufficiently to insure positive sweating in advance of the puddle, as this will allow the fluxed bronze to spread out evenly over the base metal in a thin layer to produce the tinning coating a little ahead of the main deposit. Usual practice is to point the flame ahead of the completed weld at an angle of about 45 deg., with the puddle under and slightly behind the flame, keeping the inner cone of the slightly oxidizing flame from $\frac{1}{8}$ to $\frac{1}{4}$ in. away from the surface of the metal.

If it is possible to mount the piston or other part to be re-surfaced on a special jig so that it can be turned slowly and continuously from the top toward the operator, better results can be obtained, as there will be no reason to stop during the operation and the operator can exercise better control over the thickness of the layer of deposited metal. The result will be much less machining in the finishing, and a decrease in the amount of heat during the welding operation, thus further reducing the possibility of warping.

After surfacing has been completed, the re-surfaced part should be permitted to cool slowly to normal temperature. It can then be machined to exact specifications. Figs. 6 and 7 show the details of re-surfacing two types of pistons.

Characteristics Affecting Certain Applications

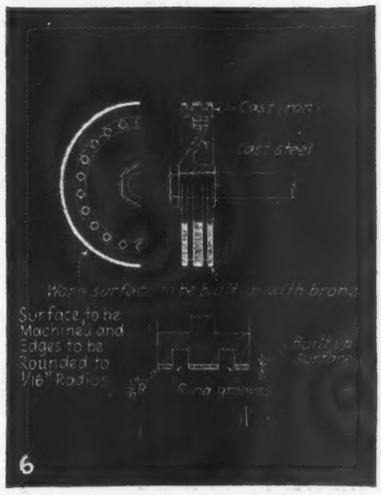
There are two special characteristics of bronze-welding which should be borne in mind. Cast iron can be built-up any number of times with bronze with entirely satisfactory results. On a steel surface, however, such as a wearing surface subjected to severe alternating and repeated stresses, there is a possibility during re-applications of bronze that the bronze-weld metal may penetrate between the grains of the steel base metal to such an extent as to cause surface checking. Therefore, it is recommended that bronze be applied no more than once for the building up of steel parts subjected constantly to such stresses.

Another characteristic is dependent upon the physical property of bronze at high temperatures. Above 500 deg. F. bronze-weld metal begins to lose its strength. For this reason there is a limitation on the use of bronze on surfaces exposed to operating temperatures higher than 500 deg. F. This temperature is rarely exceeded in industrial equipment, so that this limitation is not serious. Diesel pistons may have a temperature slightly in excess of 500 deg. F. at the crown, but the piston walls generally do not rise above 300 or 400 deg. F., and bronze-surfacing has given excellent service on engine parts operating at temperatures in the 400-deg. F. range.

Triple-expansion 2,800-hp. steam engines are used on four of one oil company's tankers. Piston diameters are: 22 in. high-pressure, 42 in. intermediate, 72 in. low-pressure. For the 22-in. piston the total cost of repair, including re-surfacing and machining, was $75, whereas a new piston would have cost $300. Corresponding savings were made in the repair of the two larger pistons. In one case, the re-surfaced high-pressure piston froze in the cylinder at first. The same 0.025-in. clearance for expansion had been allowed as in all the other cases, but it was found that a hard surface on the cylinder wall had caused the piston to stick. Of course, it was a simple matter to machine down the piston another 0.010 in., so that the difficulty was not serious, and it served to demonstrate forcibly that it is impossible to tear off the bronze-facing. This company has estimated that in the case of the high-pressure pistons alone the re-surfacing has resulted in a saving in fuel consumption of 20 barrels of fuel oil a day.

Another instance of the advantageous use of bronze-welding is in the case of large-size pistons, where cast iron is not entirely satisfactory due to excessive weight. Pistons can be fabricated from steel shapes by welding and then the wearing edges surfaced. For both of these operations the bronze welding rod is particularly adapted because of its high tensile strength, ductility and wear-resisting properties. This example, of course, represents an unusual application. A more common occurrence is the replacing of a high-priced metal by a cheaper casting surfaced with bronze.

5


Cast iron
Cast steel
Worn surface to be built up with bronze
Surface to be Machined and Edges to be Rounded to 1/16" Radius
Built up surface
Ring grooves
1/8" R
6

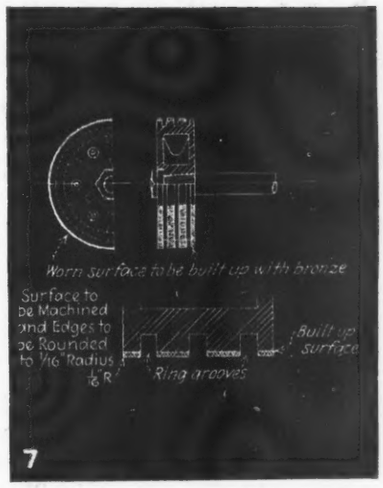

Worn surface to be built up with bronze
Surface to be Machined and Edges to be Rounded to 1/16" Radius
1/8" R
Built up surface
Ring grooves
7

Fig. 5—This bronze-surfaced vacuum pump bucket will last much longer than a new one. Fig. 6—Detail for rebuilding bull-ring type pistons. Fig. 7—Detail for rebuilding hollow-head type piston.

In one worn-out vacuum pump casting bucket rings had worn down considerably. One of these was an integral part of the bucket, another an integral part of the rear facing of the bucket, and a third was a compensating ring, which fit over the

bucket between the two other rings. All three were easily re-surfaced with bronze and machined to the proper size. Also included in this repair job was the building-up of the openings which held the discharge ring sleeves and the suction seats, a similar building up of the top and bottom spring grooves on the bronze discharge valve seats, and the replacing of the shanks on the valve guard spindles by welding onto the head a short section of round bronze bar, which was then machined to size and threaded. Such a repair job means an immediate saving of between 50 and 75 per cent of the cost of replacement, with an ultimate saving of much more because of the increased wearing power of the bronze-surfaced parts.

The replacement of pistons had always been a problem for one isolated Western oil company. Attempts had been made to enlarge the diameter of old pistons to fit rebored cylinders, but the method used was by no means satisfactory. Bronze-surfacing solved this difficulty and has been adopted as standard practice. Both bull ring and solid type pistons are used, diameters varying from 20 to 52 in. With correct procedure, there is no danger of warpage in the re-surfacing operation, and the result is a speedy and economical repair, 100 per cent better wearing surface, and a stronger piston with much longer life.

As mentioned above, re-surfacing of worn pistons on diesel engines is quite satisfactory, even at the relatively high temperatures under which they ordinarily operate. A typical example is the experience of a Northwestern logging company. It had been customary to replace at a cost of over $200 a cylinder and piston whenever wear became noticeable. Now this same company rebuilds every worn piston for less than $35. A complete determination of the saving thus made would also have to take into account the time saved by the bronze-surfacing method, and the longer life given to the parts by reason of the wear-resisting properties of the bronze and the decreased friction between the piston and cylinder wall.

Bronze-welding has also been of inestimable service in the general repair of diesel engines of all sizes. In one case cast-iron heads 5 ft. in diameter and weighing 4,000 lb. were repaired by this means after all other attempts had failed. Another time the entire bed casting of a large diesel engine was badly fractured, some of the cracks running practically the whole length of the base. Bronze-welding efficiently repaired this damage without any preheating, and resulted in a saving of almost $2,000. In a similar way cracked piston heads, crankshafts, manifolds and many other parts of these engines can be repaired and worn parts built up instead of being scrapped.

Enterprising maintenance men have found bronze welding rod extremely profitable in maintaining valves and valve parts at maximum efficiency. One company has made the rebuilding of worn rotary valves on steam exhaust engines a routine procedure. These valves are 36 in. long and 7½ in. in diameter. As they wear down in use, they also wear away the bore into which they fit. Formerly it had been the practice to redrill the bore and buy a new oversize valve, at a total cost of approximately $100 for the repair. The re-surfacing of a worn valve costs only half this much, and the bronze weld metal resists wear much better than the original metal.

CONSTANT-SPEED CONTROL OF PRIME MOVERS

By R. G. STANDERWICK

Turbine Engineering Department, General Electric Co.

UNIFORMITY of drive is of vital importance in many industrial plants. Textile machines for example, have been developed until it is perfectly feasible to operate them just 1 per cent below a danger speed at which many threads might be broken. If the textile plant can be assured that the frequency of the system will not change, even though the load varies through wide limits, then maximum production can be obtained. But if, on account of inherent characteristics in the control of prime movers, a variation in demand for power is accompanied by a small variation in speed, it is obvious that they cannot operate at the ideal speed.

It is usual for turbine manufacturers to guarantee that the speed of a turbine-generator set shall not vary more than a total of 4 per cent between no load and full load. This is termed the "width of regulation." For example, if a turbine-generator set is operating at a speed of 3,600 r.p.m. and driving a two-pole generator, obtainnig thereby 60 cycles, the full-load speed should be 3,600 and the no-load speed 4 per cent greater than this, namely, 3,744 r.p.m. As the change in speed is proportional to the load change, the speed at half load will be 3,672 r.p.m. However, in this case it was the aim of turbine control designers to hold the speed under any load condition to approximately 3,600 r.p.m.

The speed of the unit may be changed back to 3,600 r.p.m. by means of a suitable synchronizing motor, but this as a rule requires manual adjustment, and the accuracy with which turbine speed may be manually adjusted is questionable, mainly because few speed-indicating meters of reasonably low price and high enough accuracy are available. Furthermore, if the load is changing considerably, it requires the continual attention of the swtichboard operator to prevent the speed from drifting from the ideal.

Therefore, a new problem arose to be solved by the designers of control devices of prime movers. In studying this problem they found that it is not only the variation in electrical load which causes the speed of the prime mover to change, even though they may have excellent control devices, but a variation in the quantity of extracted steam for process work may cause much larger variations than would be experienced by any possible electrical load changes.

This problem has been met by the development of regulating means which automatically allow of variations in extracted steam between wide limits without affecting the speed of the prime mover by a measurable amount. When a turbine is arranged for extracting steam at more than one pressure from two or three outlets in the turbine casing, then a coordinated control to prevent speed changes becomes increasingly more complicated. But there are two other sources of speed variations, one boiler pressure, the other the vacuum in the condenser. While these may not be of great magnitude, yet if it is desired to hold the speed of a prime mover within 1 or 2 r.p.m. under all conditions that may tend to affect the speed, even small variations in boiler pressure and vacuum must be considered.

Four Reasons for Variation

So there are at least four fundamental reasons for variation in turbine speed. There are two ways for designers to tackle the problem; first, to employ coordinated control devices to anticipate and correct the speed of a turbine for variations in extracted steam, boiler pressure and vacuum, but leave room for possible variation due to electrical load changes; second, to tackle the problem at the speed governor itself.

Turbine speed should remain in a perfect state of stability at all times. This can be accomplished only by employing an accurate speed governor to indicate to the valve gear the least perceptible change of a fraction of a r.p.m. As a rule, speed governors are adjusted to 3 or 4 per cent between no load and full load, although instances have occurred where as low as 1 per cent speed change between no load and full load has been obtained by a sufficiently accurate and active speed governor.

However, it is now possible to supplement the speed governor with a hydraulic speed corrector, the action of which occurs immediately to aid the speed governor which tends to move in response to a minute speed change. This speed corrector automatically adjusts the speed setting of the governor, bringing it back to normal speed within a fraction of a second. The synchronizing motor is not used to accomplish this result, because its action is far too slow to achieve the accuracy of speed control that is being discussed.

The effect of such a device is clearly shown in the illustration, which is a curve of frequency taken in an industrial plant over a period during which the electrical load varied about 75 per cent. In this particular instance the speed corrector was applied to the governor of a 10,000-kw. condensing turbine-generator running in parallel with a 6,000-kw. condensing-extraction unit and a 6,000-kw. straight-condensing unit. The load curve of the second 6,000-kw. unit is not shown in the illustration. The load on the 6,000-kw. extraction unit is the lowest curve, the middle curve shows the frequency of the plant and the upper curve the output of the 10,000-kw. unit.

At about 11:30, the units were carrying the following loads: the 10,000-kw. unit, 2,000 kw.; the 6,000-kw. extraction unit, 4,000 kw., and the 6,000-kw. condensing unit, 6,000 kw.

The load on the condensing unit was reduced to zero as quickly as possible and the machine taken off the line, the point indicated by the first dotted line on the left. It will be noticed that the 10,000-kw. turbine immediately picked up 6,000-kw. About a minute later the load on the 6,000-kw. extraction machine was increased by the operator from 4,000 to 5,000 kw., the 10,000-kw. turbine immediately dropping 1,000 kw. load.

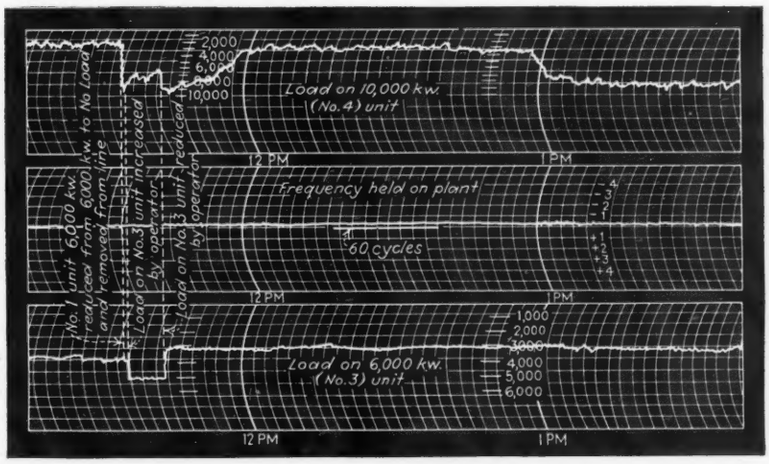
This condition was allowed to exist for about five minutes, then 2,000 kw. was dropped by the synchronizing motor from the 6,000-kw. extraction unit. The larger unit immediately picked up this amount.

Within the next few minutes plant load began to decrease on account of approaching noon-time. The 10,000-kw. unit took the entire load decrease, whereas the 6,000-kw. extraction machine remained on essentially constant load. The load dropped from 9,000 down to about 2,500 kw.

A little after 1 o'clock the load built up again on the plant, and the 10,000-kw. turbine immediately took care of the situation, the 6,000-kw. unit remaining on base load.

During all of this time the frequency remained essentially constant. Momentary speed fluctuations of not more than .1 per cent are noticeable during load changes on the plant, but the average frequency was held essentially constant. There was no manual adjustment of either the 10,000-kw. or the 6,000-kw. extraction units from the time indicated by the third dotted line for the rest of the day, and the frequency remained as shown in the curve.

The results obtained, therefore, justify installation of a turbine, the speed of which can be relied upon to be essentially constant no matter whether the electrical load, steam extraction, boiler pressure or vacuum vary. Further, by the use of such a device the frequency may be safely set at the very best operating speed with no fear of breakage in the case of the textile mills and with no necessity of operating below the ideal speed.

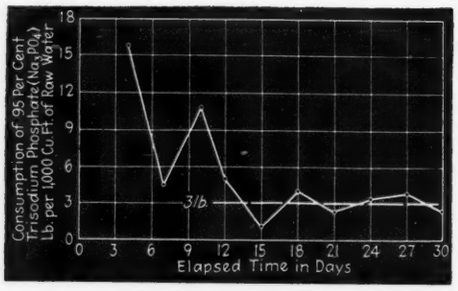


Frequency and load record of turbine equipped with constant-speed governor

HOW MUCH PHOSPHATE?

By R. E. SUMMERS
Assistant Professor, Mechanical Engineering,
Oregon State Agricultural College

"Total phosphate supplied minus total blown down minus total in boiler water equals total amount consumed"—this simple formula, applied day after day in a "phosphate balance," shows how much phosphate to supply per 1,000 cu.ft. of raw feed



Phosphate consumption plotted from last column of table

THE wide use of phosphate salts in boiler-water treatment raises the question of how best to calculate the amounts of those chemicals required for treating various waters. Determination of the proper chemical dosage for a particular case is important, but difficult. Constant variation in water impurities often makes the analysis of one or more "grab" feed-water samples of little value. The proper average water content should obviously be a working mean obtained over a substantial period of many days. Even if the true average water composition could be established in advance, it would be hard for the average operator to calculate theoretical treatment requirements from water analyses. The reader is referred to methods given in *Power* for December, 1932 (pp. 286-7), and Feb. 1933 (p. 71). Some users of phosphates make no attempt to relate the chemical feed to the water feed, but rely entirely on constant and frequent chemical checking of the results. That procedure, while fundamentally good, is not always convenient in the small boiler plant. There, periodic chemical check-up and adjustment is often served by interim (day by day or week by week) feeding of chemicals in proportion to boiler load or raw-water make-up.

A method is outlined herewith by which a form of treatment can be readily established from actual water conditions. The method makes full use of a continuous long-time water impurity record. It is built up around the chemical reactions actually encountered in practical operation. It requires only such testing procedures and equipment as are needed for checking and adjusting treatment after the treating program is under way. The method provides, furthermore, for abnormal reaction of chemicals with any small deposit of scale in the boiler at the beginning of treatment.

The method requires calculation of a number of materials balances and the plotting of one simple curve. Assume that we wish to find the approximate average amount of 95 per cent pure crystalline trisodium phosphate needed to precipitate hardness from a relatively soft make-up water. It is evident that, any time after treatment has been started, chemicals can be accounted for by the equation:

Phosphate Consumed = Gross Supplied — (That Present + That Lost).

Where a record is kept of the phosphate supplied to a boiler through a period, the amount of phosphate consumed by reaction with water impurities can be calculated if the amount of free phosphate in solution is known and if losses in blowdown, etc., are known, or can be estimated.

An illustration may be drawn from the table for data of the 24th and 27th days of operation of the boiler studied. Every part per million of phosphate radical (PO_4) found in water of the given boiler represented 0.18 lb. of trisodium phosphate as measured (based on 24 per cent active PO_4 and 5,000 gal. of boiler water). It is seen that the phosphate in the boiler the 24th day was, with 60 parts per million PO_4 in solution, $60 \times 0.18 = 10.8$ lb. On the 27th day, with 20 parts per million PO_4, it was 20×0.18 or 3.6 lb. The phospate consumed in the entire time to the 24th day was, by the

PHOSPHATE ACCOUNT

Days After Start	Gross Supplied, Lb.		Amount in Solution, Lb.	Blowdown Loss, Lb.		Raw Water Increment, Cu.Ft.	Net Consumption in Pounds		
	Increment	Total		Increment	Total		Total	Increment	Per 1,000 Cu.Ft. Water
0	10.0	10.0	....	0.0	0.0	0	0.0	0.0	....
2	5.4	15.4	....	0.0	0.0	0	....	....	....
4	5.4	20.8	0.9	0.0	0.0	1260	19.9	19.9	15.8
7	19.0	39.8	11.7	0.6	0.6	1680	27.5	7.6	4.5
10	4.5	44.3	10.8	0.0	0.6	500	32.9	5.4	10.8
12	12.5	12.5*	9.0	0.0	0.0*	700	3.5*	3.5	5.0
15	7.0	19.5	12.6	1.8	1.8	1500	5.1	1.6	1.1
18	16.0	35.5	15.3	1.8	3.6	2980	16.6	11.5	3.9
21	4.3	39.8	10.8	3.2	6.8	2435	22.2	5.6	2.3
24	5.0	44.8	10.8	0.0	6.8	1515	27.2	5.0	3.3
27	0.0	44.8	3.6	2.0	8.8	1330	32.4	5.2	3.9
30	7.0	51.8	6.3	0.0	8.8	1785	36.7	4.3	2.4

(*) Boiler inspected. New series of records started.

equation, 44.8—(10.8+6.8)=27.2 lb. The amount consumed by the 27th day was 44.8—(3.6+8.8)=32.4 lb. The phosphate consumption from the 24th to the 27th day was, therefore, 32.4—27.2=5.2 lb. In the same period the raw water makeup to the boiler was 1,330 cu.ft. by the plant meter. The phosphate demand indicated was, per 1,000 cu.ft. of water,

$$5.2 \times \frac{1{,}000}{1{,}330} = 3.9 \text{ lb.}$$

That result is plotted on the phosphate-demand curve at the position for the 27th day from the start of the trial.

The normal demand of the raw water for treatment is seen, from the figure, to approximate 3 lb. to the thousand cubic feet. That amount may be made the basis of routine treatment. Termination of rapid reaction of treatment with residual boiler scale is seen in the falling of the demand to a constant value at about the 15th day. Fluctuation in demand about the normal during the last half of the trial may represent experimental error or it may be caused by variation in the impurity content of the raw water.

In conclusion, it should be recognized that there is, in boiler water treatment, no substitute for precise and known control of chemical conditions. This method of practical chemical proportioning based on water conditions is not intended as a substitute for systematic check-up on developed conditions. It is useful because it gives an approximate average as a guide to daily operation. It is often helpful in the small, medium-capacity boiler plant where warranted or feasible chemical analyses of boiler water consist of periodic, possibly week by week, tests. Those tests can then be made the basis of adjustment to the norm or average approximated by the results of the procedure just described.

[Right of republication of this article or any related description of the procedure presented therein is reserved by the author]

INERTIA SUPERCHARGING OF A SEMI-DIESEL ENGINE

By A. H. ZERBAN

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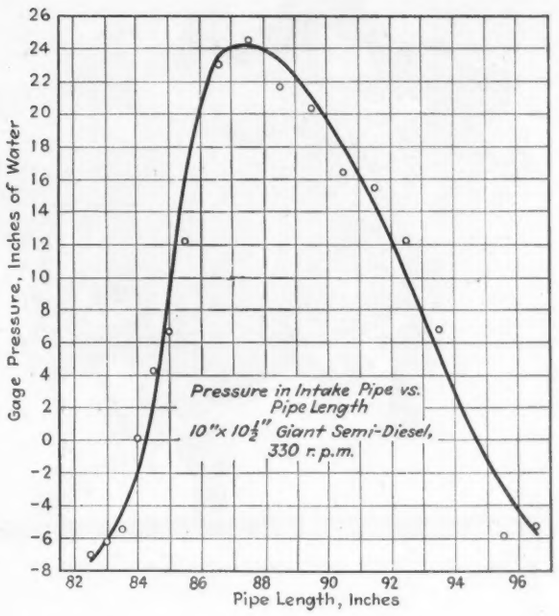
The Pennsylvania State College

IT IS generally recognized that, by adjustment of air inlet pipe length, a constant-speed engine can be supercharged to a certain extent. This has been the subject of investigation by a group of senior mechanical engineering students working under my supervision.

The engine was a 2-cycle Giant semi-diesel, manufactured by Chicago Pneumatic Tool Co., and rated 20 hp. at 350 r.p.m. The engine is automatically governed by regulation of fuel-pump stroke to suit load. We took a given length of intake air pipe and measured the pressure in the pipe at the instant the port leading into the lower part of the cylinder was uncovered by the piston on its upward stroke. A section of galvanized-iron pipe was slid over the end of the regular inlet pipe to vary pipe length as desired. For accurately measuring the pressure at the instant considered, a balanced-diaphragm indicator was used. This indicator was fitted with a manometer and a means for obtaining either a positive pressure or an aspirating effect on the diaphragm. For timing the pressure determination, an electric contact was made on the flywheel of the engine.



The test results, corrected for the tare of the indicator diaphragm, are shown by the curve.

According to THEO. J. DICK

THESE ARE THE ANSWERS

to test questions on page 431

1. Force is that which tends to produce or destroy motion—it is a push or a pull. Force, like heat, can be measured only by the effect it produces on a substance. The pound is the usual engineering unit for measuring force.
2. I. All bodies continue in a state of rest, or of uniform motion in a straight line, unless acted upon by some external force that compels a change.
   II. Every change of motion is proportional to the acting force and takes place in the direction of the straight line along which the force acts.
   III. To every action there is always opposed an equal reaction.
3. 50 lb.
4. No. Unless a force **overcomes** a resistance, work is not done. If a little more than 100 lb. of force is exerted, the body in question will be lifted and work will be done. Two things are necessary for work to be performed: first there must be a force, and second, there must be a motion in the direction of the force.
5. Yes.
6. Inasmuch as the unit by which force is measured is the "pound" and the unit of measure for distance is the "foot," and inasmuch as work is a combination of force and distance, the unit of work is the foot-pound. It is the amount of work done by a force of one pound acting through a distance of one foot.
7. 100 × 2,000 = 200,000 ft. lb.
8. F = area of piston × 100 = 8 × 8 × 0.7854 × 100 = 5026 lb.
   D = 10 in. = 5/6 ft.
   W = 5,026 × 5/6 = 4,189 ft. lb.
9. Power is the rate of doing work. If one machine can do a piece of work in 5 min., and a second machine requires

(Continued on page 460)

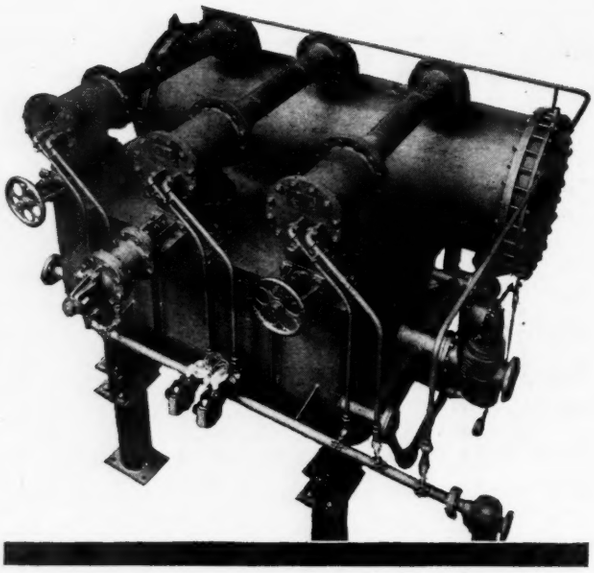


Fig. 1—General arrangement of 75-ton steam-jet unit

REFRIGERATION

WHAT . . . WHEN . . . WHY

Nearly seventeen years ago commercial steam-jet units went into service. Today they are "newly discovered"

STEAM-JET refrigeration is not, as many engineers have supposed, a new development. It, however, had never been given any great attention until recently, although commercial units were in operation nearly seventeen years ago. Many conditions have come about in the past ten years that favorably effect commercial applications of steam-jet refrigeration among which may be listed:

1. Improvement of boiler and stoker efficiencies, resulting in production of steam at low cost.

2. Improvement of the steam-jet compressor, with a reduction in steam consumption of approximately 25 per cent.

3. Changes in design which have lowered cost, principally by reducing the number of parts.

4. Development of highly efficient small and medium-sized, steam-actuated air ejectors to replace hydraulic and rotative dry-vacuum pumps. This materially reduced first cost of the apparatus and, likewise, power requirements.

5. (*a*) Bleeder-type turbines, condensing or non-condensing, in industrial plants have provided sources of medium- and low-pressure steam at relatively low cost.

(*b*) Central heating systems—lower cost of production of steam.

6. Condenser size has materially decreased, due to improvements which increased the rate of heat transfer approximately 350 to 650 B.t.u. per sq.ft. per deg. per hr. This reduces the area of surface and the amount of water required for cooling (with its attendant reduction in power).

7. Radical improvements in cooling-tower design have been made, improving the cooling effect and reducing the power and weight required for a given amount of cooling.

8. The demand for air-conditioned industrial plants and comfort cooling and air-conditioning of large buildings has been sufficient to warrant manufacturers spending large sums to further this development.

Today the field of application of steam-jet refrigeration is broad, embracing industrial and comfort cooling, but each case should be decided upon its merits. It is essential that a source of steam be available at reasonable cost, possibly not exceeding one dollar per thousand pounds. Likewise, a source of water must be available at a reasonable pumping charge. Summarized, a few specific possibilities are:

1. Air-conditioning and cooling rooms for industrial processes or comfort.

2. Application where water at a low temperature is required for process work.

3. Air conditioning and cooling office buildings, theaters and halls.

4. Application to the petroleum industry.

5. Cooling of dining saloons and cargo aboard ships, and possibly magazine cooling of armored ships.

Vacuum Cooling Analogous to Cooling Tower

The operating principle of the steam-jet compressor may be compared to that of a cooling tower. Warm water entering the tower is exposed to the air in a fine spray, and as the air is capable of absorbing a certain quantity of vapor, it takes vapor from the water circulated. Every pound of vapor thus absorbed requires approximately 1,000 B.t.u. for its evaporation. Therefore, the water circulated is robbed of as many thousand B.t.u. as there are pounds of water absorbed.

Vacuum cooling is a true analogy to the cycle in the cooling tower. In both systems the liquid to be cooled efficiently must be divided in a fine spray for rapid evaporation. However, instead of evaporating at a relative high temperature and at atmospheric pressure, as in the cooling tower, we must in the case of the steam-jet compressor evaporate the water at low temperature and consequently at a low absolute pressure, or in other words, under a high vacuum.

Further, instead of absorbing the vapor by a natural current of air of a varying humidity, as is the case in a cooling tower, the vapor is removed through difference in pressure and in predetermined amounts.

Extending the comparison, consider from what source heat is removed in a refrigeration unit. The water is at some temperature, say 52 deg. Assume that chilled water at 46 deg. F. is desired. To obtain this lower temperature heat must be removed from the water. The pressure is reduced to the point where water boils at 46 deg. Into this same chamber we in-

BY STEAM JET

WHERE . . . . HOW

By D. W. R. MORGAN
Steam Division,
Westinghouse Electric & Mfg. Co.

troduce water at 52 deg. It boils and part of the water is converted into vapor. The heat of vaporization is removed from the main body of the liquid, thereby reducing its temperature. The 6-deg. temperature difference is equivalent to approximately 6 B.t.u. per lb. of water. It requires, however, about 1,000 B.t.u. to convert one pound of water into steam, therefore, to cool one pound of water from 52 to 46 deg., 0.006 lb. of water must be evaporated.

To maintain the reduced pressure necessary to evaporate continuously at 46 deg., the vapor must be removed at whatever rate it is produced, with, for example, a reciprocating pump. At the pressure at which boiling occurs a large volume of vapor must be displaced. One pound of vapor at 46 deg. has a volume of 1,965 cu.ft. Approximately 12 lb. must be evaporated per hour per ton of refrigeration. Therefore, for each ton of refrigeration, 393 cu.ft. of vapor per minute must be removed. This would require, in the case of a single-acting pump, a piston 15 in. in diameter and a stroke of 2 ft. operating at 200 r.p.m. This illustrates the desirability of considering apparatus for removal of vapor that will require less space and maintenance.

Steam-Jet Compressor Produces Low Pressure and Temperature

Vacuum cooling is accomplished through the use of the apparatus illustrated in Fig. 2 and consists of:

(*a*) Steam-jet compressor, commonly called booster ejector,

(*b*) An evaporator or cold tank,

(*c*) Condenser of surface, jet or barometric type.

(*d*) Steam ejector, reciprocating or hydraulic type air pump, for removing air from the condenser system,

(*e*) Pumps for circulation of water through condenser, removal of condensate from condenser, cold-water pump for circulation of chilled water.

The steam-jet compressor produces the high vacuum and low temperature. It consists of two parts, each performing an entirely different function. The steam nozzles transform potential into kinetic energy, and the diffuser compresses the mixture of steam and vapor. Leaving the nozzles at high velocity, the steam aspirates the vapor from the evaporator. The mixture of steam and vapor, being at a lower absolute pressure than exists in the condenser, must be compressed to the condenser pressure by the diffuser, thereby converting a part of the velocity again into pressure.

A fundamental feature of the steam-jet compressor is the application of the De Laval expanding nozzle, which produces an approximately linear jet of steam whose kinetic energy nearly corresponds to the total drop in pressure, the efficiency of such a nozzle being 95 per cent. Fig. 3 shows the Le Blanc application of the same principle to a steam-jet compressor. Steam prior to entering the nozzle has zero velocity. Having passed through the entrance to the throat, it attains a velocity approximating 1,200 ft. per sec. The pressure at the throat is about half the initial pressure.

As it passes through the nozzle cone, the steam expands adiabatically to the evaporator pressure, reaching a velocity of approximately 5,000 ft. per sec. at the nozzle outlet. This increase in velocity represents work done on the steam while expanding to the low absolute pressure zone. Steam expanding adiabatically must do work, and since no external work was performed in the nozzle, the steam works upon itself, and this work is manifested by a large increase in velocity. Leaving the nozzle at a high velocity, the steam creates an intense suction, carrying with it the vapor from the evaporator.

If the velocity remained the same until the steam reached the condenser, the pressure, and consequently the temperature in the evaporator, would correspond to

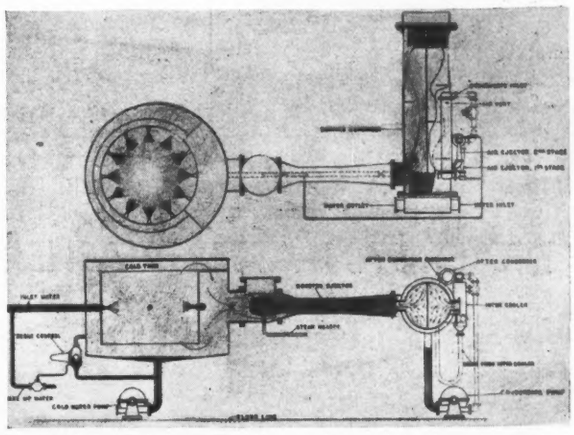


Fig. 2—Steam-jet system used for temperatures over 35 deg.

the temperature in the condenser. The refrigerating effect would be small, since the temperature in the condenser may range from 80 to 100 deg.

To obtain low temperatures in the evaporator, low absolute pressure must be maintained, and the steam and vapor from the low-pressure zone must be compressed to the existing pressure within the condenser. This is accomplished by gradually reducing the area of the nozzle chamber, thereby forming a diffuser. The smallest part of the diffuser is called the "throat," the point where the compression is completed. Further, reduction of velocity is obtained by making the exit of the diffuser a cone-shaped extension, as shown in Fig. 4.

Next in importance is the design and construction of the evaporator. The principal objective of the designer is to minimize the losses that occur within the evaporator. These are:

1. Terminal temperature difference.
2. Mechanical entrainment or carry-over.
3. Difference in pressure from zone of evaporation to inlet of the compressor.
4. Refrigeration of make-up.
5. Radiation and conduction.

Obviously the temperature of the refrigerant will be slightly higher than the temperature corresponding to the pressure in the evaporator. This difference is usually referred to as the "terminal temperature difference." The reason for this is apparent when one considers the phenomena of flash cooling. Mechanical carryover is minimized by providing sufficient area to obtain relatively low vapor velocity in the evaporating zone.

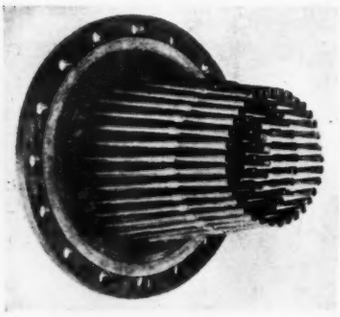
A difference or drop in pressure between the evaporating zone and the compressor inlet results in a loss of efficiency, this loss approximating 2½ per cent for each 0.01 in. mercury difference in pressure, and emphasizes the need of liberally designed passage for flow of vapor from the evaporator to the compressor.

The additional water for make-up should be obtained from the coldest source available, with due consideration of quality of water introduced. Radiation and conduction losses can be reduced to a negligible amount by the application of efficient insulation.

Automatic Control Lowers Operating Cost

There has been considerable use for automatic controls to decrease or increase tonnage by regulating the number of units in service. Fig. 1 shows the general arrangement of a 75-ton unit, each compressor having a capacity of 25 tons. Two of the compressors are non-automatic and are used for the base load demand. The third is automatically controlled, and is responsive through a thermostat to changes in temperature of chilled water. Assuming the automatic compressor is out of service and the demand increases, the thermostat actuates a motor-driven valve governing steam supply to the starting nozzles. After a short interval, a valve opens in the steam supply to the operating nozzles, and this is followed in sequence by closing the valve supplying steam to the starting nozzles. When the capacity exceeds the demand, the ejector is cut out of service, automatically closing the valve of steam supply to the automatic compressor.

A second article on steam-jet refrigeration discussing performance will appear in the September number.



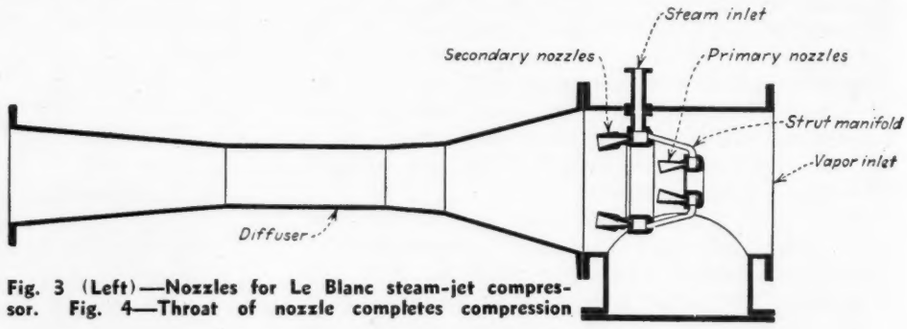


Fig. 3 (Left)—Nozzles for Le Blanc steam-jet compressor. Fig. 4—Throat of nozzle completes compression

DRAFT FAN AFTER WASHER

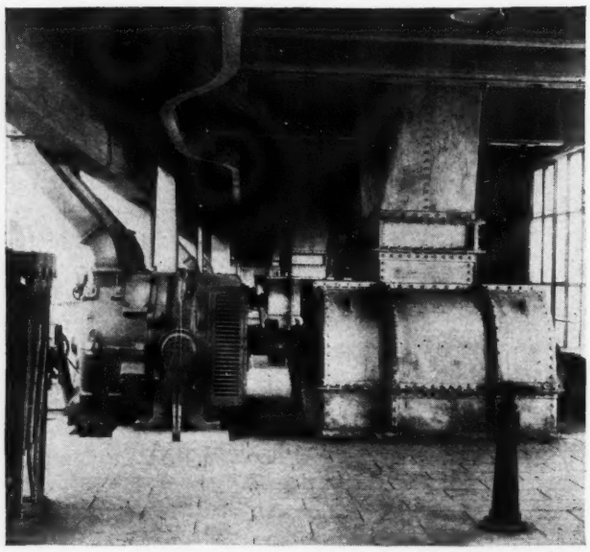
By J. GOULD COUTANT
Fuel Engineer

TWO IMPORTANT European power stations, St. Denis in Paris and Maurits Mine in Holland, are successfully utilizing the Modave system of flue-gas washing, with induced-draft fans placed beyond the washer. This saves power because cooler gases are handled and is claimed not to produce undue deterioration of the fan.

St. Denis is near the densely populated manufacturing district of Paris, hence must purify its chimney gases. Boiler fumes traverse a 5,600-sq.ft. tubular air preheater, then pass into the washer where 90 per cent of the solids, and most of the acids, are removed. At maximum output, 485,000 lb. of gas went to the purifier per hr. at 422 deg. F. Purifier gas resistance was 0.71 in. w.g. and gas temperature leaving was 250-260 deg. F. Using 176,400 lb. of water, the system recovered 1,168 lb. of dust, an efficiency of 90 per cent. By cooling, gas volume was reduced 25 per cent, thus compensating for the resistance of the washer in power required for the fan.

Maurits Mines has two boilers with 220,000-lb. per hr. steam capacity, at 750 deg. F. and 500 lb. pressure. Fuel is powdered coal, mine dust, etc. The washers cut gas temperature 125-175 deg. and are 90 per cent efficient.

Société des cheminees Louis Prat motor-driven induced draft fans at St. Denis are unlined, yet receive moist flue gas from the scrubbers



DEAD or ALIVE?

THE POWER GAS PRODUCER IS ALIVE

Says LUDWIG LUSTIG
Chief Engineer, Deutz Motor Corp.

In America the power gas producer lies dead and almost forgotten. Yet, in Europe, it has staged a comeback—practical, easy to operate and a notably cheap source of power and process heat.

IN AMERICA, gasification in gas producers and the application of gas generators and gas engines have a history. I shall merely mention the comprehensive research and investigations made by Professor Fernald, the present dean of mechanical engineering at the University of Pennsylvania. These were published a short time before the World War; a map showed the geographical distribution of such installations in the U.S.A. After that time, however, the use and development of such plants declined. The engines operated economically, but the problems of gas purification were still imperfectly solved, and operation of such plants necessitated more work than did a diesel engine or a steam boiler with turbine.

In European industrial districts, however, the application of producer gas for power and heat has steadily been increasing again for the past eight years, because improved construction has completely removed previous difficulties. Comparing a producer-gas heat-and-power unit of 1934, in its simplicity and automatic mechanism, with a gas plant of 1912 would be like comparing a modern automobile with a car of that time.

Gas-power plants are today so simple and automatic that operation is no longer a problem. Installation of modern producer plants would improve production and materially reduce cost in many industries.

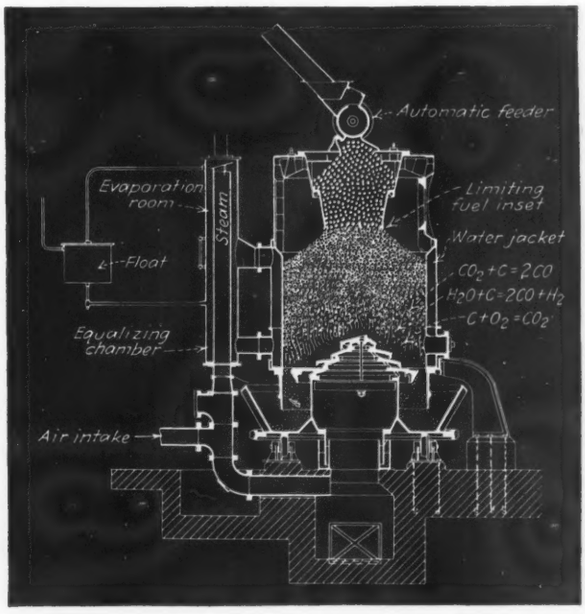
In a modern large brewery, for instance, the power can be supplied by the gas engine. Waste heat from gas generator and engine will furnish all hot water for filling the brew-kettles and for the bottle-washing machines, as well as the steam for disinfecting the barrels. Part of the producer gas is applied directly to heat the brew-kettles. After all the power and heat have been utilized in this manner with the least possible loss, the cold exhaust gas can be employed for the production of solid carbon dioxide. Similar applications are possible in bakeries, noodle factories, fish and meat canneries, wire and cable works, porcelain and enamel manufacture and other industries.

Apart from the above-mentioned modes of application, the gas engine has again become important for the exclusive production of power. A normal or supercharged gas engine, inclusive of gas generator, is more economical up to 3,000 hp. than a condensing steam turbine and high-pressure boiler.

In comparing the producer-gas engine with a solid-injection diesel engine, which has the best thermal efficiency of all combustion engines, the lower cost of the fuel consumed by the gas engines must be considered. Despite this we must give the diesel engine the preference for ships, where the storage capacity of fuel and cargo are important, as well as for all peak-load purposes in power stations, and as principal motive power in plants which work only one shift, or longer with frequent intermissions.

Basically different from open combustion and the dry distillation of the coke oven, gasification in the gas producer represents a reduced combustion. Here is process in brief: First, normal combustion takes place in the fire zone, according to the formula $C + O_2 = CO_2$. As the supply of oxygen is limited in the reduction zone above the combustion zone, the carbon dioxide formed in the lower zone splits in the presence of still-unburned red-hot carbon, according to the formula $CO_2 + C = 2CO$. The steam, which has passed into the generator with the air, likewise splits in the reduction zone, according to the formula $H_2O + C = CO + H_2$. The resulting useful constituents of the producer gas are chiefly carbon monoxide (about 30 per cent) and hydrogen (about 14 to 16 per cent). The remainder consists of unburnable nitrogen, with small

Section of a gas producer with water chamber and revolving grate



quantities of CO_2 and methane (CH_4) also included.

With antiquated generator types the red-hot coal often sintered onto the red-hot refractory lining and thus impeded the downward movement of the coal. In removing the obstruction by poking, the fireman frequently damaged the fire-bricks. The wall temperature of a modern gas producer with water jacket does not exceed the boiling point, so that all those difficulties are obviated. The water jacket of the patented Deutz generator is connected to an equalizing tank, which protects the water jacket from admission of air and its corroding effect on the water jacket and which insures a thermal circulation of the water.

The gas producer with water jacket admits about 8 per cent of the heat of the fuel into the water jacket. About one-half of this heat is required to produce steam for the saturation of the introduced air, while the remaining half is available as waste heat for general heating and process.

Correct mixing of steam and air supplied under the grate is essential for a uniform quality of gas. The steam has three functions: cooling and protecting the grate, cooling the hot ashes to prevent their fusing, and finally, the dissolution into H_2 and O. Too much steam will give trouble and may even extinguish the fire. Too little steam, on the other hand, means a surplus of air supplied to the fire bed, causing regular combustion within the producer instead of gasification. Difficulties of this kind are eliminated with modern gas producers by thermostat-governed satuation of the air.

The revolving grate of the gas producer already mentioned consists of spiral steps, which because of the weight of the coal, force the ashes downward and outside into the water-filled ash-pan, whence they are discharged automatically.

The fuel pocket in the upper part of modern gas producers insures uniform replenishing of fuel at all times without manual work. This is important, for the uniform analysis of the gas depends upon the constancy of the fuel level and its air resistance.

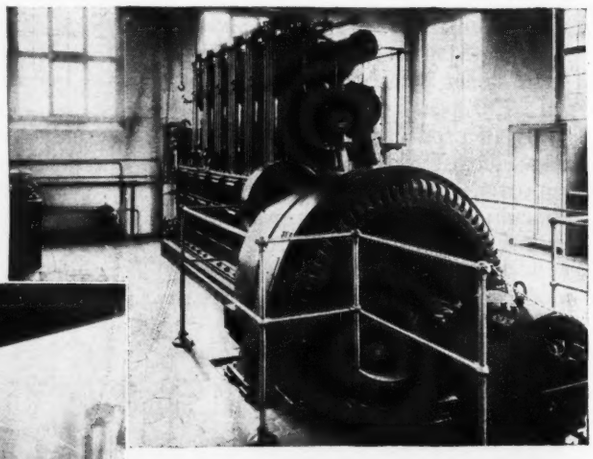
Coal feeding likewise is automatic. In the upper part of the generator is a cell sluice with several shelves. Underneath this cell sluiced a shovel-shaped lever is arranged, with a counterweight on the other side of the fulcrum. When the coal has sunk so far that the shovel is empty, the counterweight works a mercury switch which starts the fuel elevator and stops it again when the fuel inset is filled. No elevated coal bunkers and no large structures are necessary; the elevator lifts the coal, in proportion to its consumption, from a deep-level coal-bunker directly at or underneath the siding. In this manner the coal feed is automatic but practically dustless.

Depending upon the utilization of the gas and upon the kind of fuel, the gas producer is fitted with different kinds of purifying equipment. Some gas applications require only a dust separation, after which gas may be used with its entire content of heavy hydrocarbons and sensible heat. Here the useful heat in the producer gas may be 90 per cent of that in the coal used. For most applications, however, including power production, the gas has to be cooled and more intensively cleaned. Sometimes cooling is followed by electrostatic elimination of dust and air.

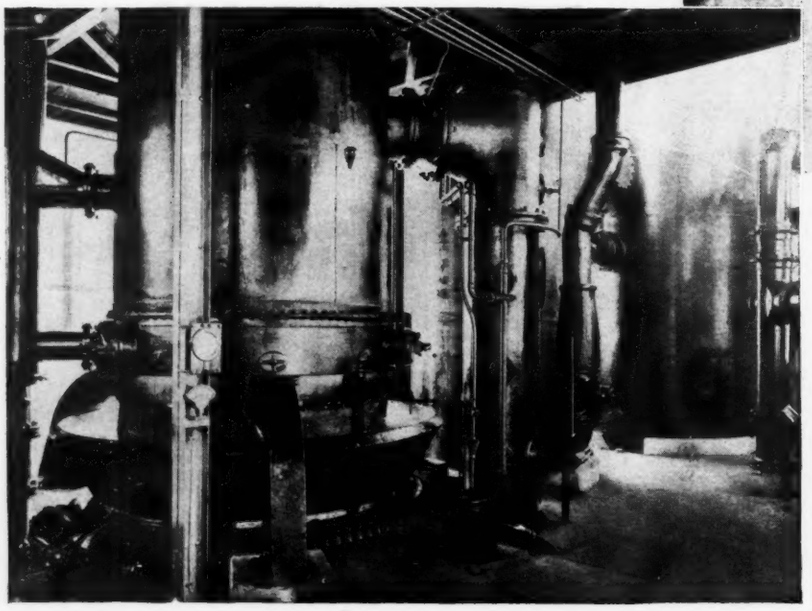
The most approved method of cleaning producer gas is a combination of mechanical and chemical dry cleaning. It would lead too far in this article to go into the details of gas purification, which depends on the application of the gas and on the kind of fuel.

The modern revolving-grate producer operates with an efficiency of 78 to 82 per cent from solid fuel to purified cooled gas, and with an efficiency of 88 to 92 per cent based on hot raw-gas output. Efficiency of the modern producer decreases only 2 per cent from 100 per cent load to 30 per cent.

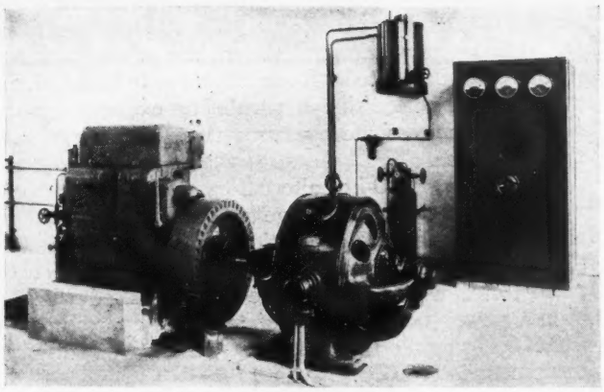
Modern horizontal and vertical 4-cycle gas engines



Above—500-hp. producer-gas engine



Left—Gas plant in a brass factory



60-hp. convertible set which operates on either fuel oil or producer gas

are often designed for alternate use as diesel engine and gas engine.

The Table I gives economic comparisons of producer-gas engine, diesel engine and steam turbines (condensing and non-condensing). The internal-combustion engines are modern standard types without supercharging. The normal output of 750 b.hp. of each type corresponds to 500 kw. at 80 per cent power factor. It is easy to see that the producer-gas engine works very economically even as a power generator without waste-heat utilization. The first cost of a gas-power unit, however, is 30 to 50 per cent higher than that of a modern diesel unit, but is about the same as that of steam turbine with its boiler plant.

The available waste heat for internal-combustion engines, including gas producers, as shown in the table, consists of steam up to 40 per cent, and up to a pressure of 86 lb., whereas the balance of the waste heat is usable in form of hot water up to 190 deg. for all kinds of industrial washing, mixing, warm-water heating, or drying.

Finally, one must not overlook the importance of producer gas as a fuel for industrial furnaces. Table II shows that the energy cost (not counting fixed charges and labor) of producer gas is less than half that of fuel oil and only about 10 per cent that of city gas (at 70c. per 1,000 cu.ft.). Furnaces now available employ photocells to regulate gas and air supply.

Table I—Economic Comparison of Different Kinds of Power Production

Kind of Engine	Producer Gas 750 b.hp.	Solid Injection diesel 750 b.hp.	Turbine 750 b.hp. 450 lb. Pressure 750 deg., 25-in. Vacuum	Turbine 750 b.hp. 450 lb. Pressure 750 deg., 1 lb. Back Pressure
Fuel	Anthracite rice thru 5/16 in., over 3/16 in., 14,000 B.t.u./lb.	Fuel oil No. 3 18,000 B.t.u./lb.	Pulv. coal 13,000 B.t.u./lb.	Pulv. coal 13,000 B.t.u./lb.
Price, f.o.b. N. Y.	$3.85/ton	$0.045/gal.	$4.00/ton	$4.00/ton
Fuel Consumption:				
lb./b.hp./hr.	0.750	0.385	1.26	2.65
B.t.u./b.hp./hr.	10,500	6,750	16,200	34,500
Fuel cost/b.hp./hr.	$0.00145	$0.00232	$0.00250	$0.00530
Thermal efficiency, incl. boilers and gas generators but without waste heat recovery, per cent	24	37	15.4	7.3
Fuel consumption:				
B.t.u./kw.-hr.	15,800	10,200	24,500	52,000
(p.f. = .8) lb./kw.-hr.	1.24	.56	1.9	4.00
Fuel cost:				
per kw.-hr.	$0.00217	$0.00345	.00375	.00800
500 kw.-hr.	$1.085	$1.725	$1.875	$4.00
Available waste heat B.t.u. per kw.-hr.	6,000	4,500	(condens.)	41,000

Table II—Actual Cost of 10,000 B.t.u. eff. from Various Sources

	Electric Current	Fuel Oil No. 3	Illum. Gas	Producer Gas
Heat Unit	3,415 B.t.u./kw.-hr.	18,000 B.t.u./lb.	530 B.t.u./cu.ft.	14,000 B.t.u./lb.
Price Unit, dollars	0.010/kw.-hr.	0.045/gal.	0.07/100 cu ft.	3.85/ton
Based on furnace thermal efficiency	85%	50%	50%	40 (incl. prod.)
Cost 10,000 B.t.u. effective applied heat	0.0342	0.0069	0.0265	0.0029

NEW PLANT SAVES $10,500

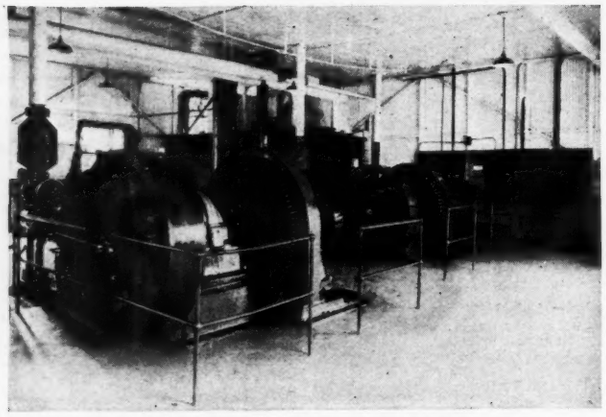
By GEORGE SPURGEON

Chief Engineer, Dairymen's Cooperative Creamery Assn.

UNTIL a year ago, the Tulare, Calif., plant of the Dairymen's Cooperative Creamery Assn., one of seventeen cooperative diarymen's plants, known as the Challenge Cream & Butter Assn., operated on purchased power with an average monthly consumption of 43,800 kw.-hr. costing $637, an average of $0.0145 per kw.-hr. Steam was generated in three 1,000-sq.ft. H.R.T. boilers, burning oil which cost $0.66 a bbl. Average monthly oil consumption was 1,050 bbl., costing $693.

Insufficient firebox area prevented our old H.R.T. boilers from being forced above their rating, and it was necessary to operate all three of them continuously. This condition, without standby boiler protection, was a serious one, and in the summer of 1931 the board of directors decided to install a battery of modern water-tube boilers, and at the same time to modernize power-plant equipment.

In connection with these changes, the question of power generation came to the fore. Investigation showed that certain plant changes and the installation of a unaflow engine-generating set would permit generating the major portion of the electric power requirements as a by-product of the low-pressure steam and hot-water requirements. The directors, therefore, decided to install generating equipment along with the needed new boiler installation. A hot-water storage tank and heater coil were also installed and some changes were made in plant operations, such as the use of hot water heated by the exhaust steam for the washing of cans, etc., in place of using the former inefficient method of heating the water by live steam jets at the point of use. All of the old steam piping, which had



These engines save dairymen $5,449 a year

been run more or less haphazard through the plant as growth required additional extensions, was replaced with new runs, and all new piping was well insulated.

Either of the two new 2,070-sq.ft. Heine water-tube boilers operating at 150 lb. pressure will handle the complete steam load, so that one boiler is in standby at all times. With the new boilers, which were installed with modern settings, such that the boilers can be forced, if necessary, to 300 per cent of rating, we have realized an improvement in boiler efficiency of approximately 20 per cent. Adequate pipe insulation has made an additional steam saving of approximately 10 per cent. The new boilers are gas fired, gas costing $0.13 per 1,000 cu.ft. of 1,100 B.t.u. gas.

The unaflow engine is direct connected to a 100-kw., 25 per cent-overload capacity alternator; with one counterflow engine direct-connected to a 100-kw. alternator for standby protection. Exciters are of such a size that either will excite both alternators at full load, doing away with the necessity of paralleling exciters if occasion should necessitate operating two generator sets at the same time.

The two new 100-kw. alternators, switchboard, Skinner engines, hot-water storage tank and heater installed, and chargeable to generation, cost approximately $21,000. The two new boilers, setting, burners, steam piping, etc., which would have been installed whether or not power was to be generated, cost approximately $30,000, bringing the total cost of new power-plant equipment to $51,000.

The new boilers had to be installed irrespective of the generator installation, and the major portion of the saving is made by the engines. Taking the investment in the engine-generating equipment of $21,000 and charging 13 per cent fixed charges, we have an annual fixed charge of $2,730, or $227.50 per month, against an operating saving under present operation for electricity alone of $712.47 per month. A net saving after fixed charges is therefore made by the engines of $712.47 — $227.50, or $484.97 per month, or $5,449.64 per year.

A résumé of operations per average month before and after the installation of the new equipment is given at left. Labor costs are not included, as installation of the generating equipment necessitated no increased labor. Repair costs are not included, as these have amounted to but $5.57 for the nine months of operation.

The lubricating oil used by the engine, due to its automatic recirculating oil system, is so small that it has been neglected in the following résumé. Attention is called to the fact that due to increased plant operation and the installation of additional electric- and steam-using equipment, the kw.-hrs. used by the plant and also the plant steam load have been materially increased.

Resume:	Before new installation	After new installation
1. Cost of new boilers, dollars		30,000
2. Cost of boilers, piping, etc., dollars per rated h.p. installed		75
3. Cost of boilers, dollars per maximum hp. developed		25
4. Cost of engines, generators, switchboard, etc., installed, dollars		21,000
5. Maximum capacity of generator equipment, kw		250
6. Cost of generator equipment, dollars, per kw		84
7. Average kw.-hr. used per mo	43,800	56,800
8. Cost of purchased kw.-hr. per mo	$637	none
9. Fuel burned per mo., approx	1,050 bbls. oil	8,644,000 cu. ft. gas
10. Total pounds live steam used, per mo	3,540,000	6,709,020
11. Cost of fuel to make all live steam, dollars per mo. fuel at $0.66/barrel, gas @ $13/1000 cu. ft	693	1,123.76
12. Live steam used through engine, lb	none	1,809,000
13. Live steam to plant, lb. per mo	3,540,000	4,900,020
14. Steam used per mo. for heating, etc. after leaving engine, lb	none	1,169,486
15. Steam chargeable to generation, giving no credit for returns to hot well, lb	none	652,072
16. Cost of steam charged to generation at $0.1675 per 1,000 lb	none	109.33
17. Cost of electric power for present increased operations, based on old average rate of $0.0145 per kw.-hr. and present consumption of 56,800 kw.-hr.	822	
18. Direct saving in electric power costs based on present increased operations $822–$109.33, dollars		712.47
19. Cost of steam per 1,000 lbs., dollars	194	.1675
20. Cost of present steam consumption if generated in old boilers 6,709,000x 0.194, dollars	1,300.00	
21. Cost of present steam consumption 6,709,000 x 0.1675, dollars		1,123.76
22. Saving in steam costs because of new boilers, based on present total consumption, $1,300-1,123.76, dollars		176.24
23. Cost of present process and heating steam, if generated in old boilers, 6,069,506 x 0.194	1,177.48	
24. Total saving in electrical costs and steam costs based on present increased operations as against old costs for equivalent operation $1,999.48–1,123.76		875.72
25. Per cent increased power consumption due to increased operations 56,800 ÷ 43,800 = 130 per cent		30
26. Per cent increased steam consumption due to increased operations 6,709,020 ÷ 3,540,000 = 190 per cent		90

THEO. J. DICK'S ANSWERS

(*Continued from page* 453)

10 min. to do the same work, then the first machine has twice the power. The element of time enters into calculations relating to power, because power is the **rate** of doing work. The unit of power used in engineering work is the horsepower and it is 33,000 ft. lb. of work performed in one minute.

10. 500,000 × 100 = 50,000,000 ft. lb.
50,000,000 ÷ 60 = 833,333 ft. lb. per min.
833,333 ÷ 33,000 = 25.4 hp.

11. No. If an engine is doing work at the rate of 60 hp. it is doing 60 hp. all the time.

12. a. 778.
b. 778 × 14,500 = 11,281,000 ft. lb.

13. $\frac{33{,}000 \times 60}{778} = 2{,}545$ B.t.u.

14. a. 100 × 70 = 7,000 lb.
b. 7,000 × 1 = 7,000 ft. lb.
c. 7,000 × 100 (working strokes) = 700,000 ft. lb. per min.
d. $\frac{700{,}000}{33{,}000} = 21.21$ hp.

15. a. $\text{Efficiency} = \frac{\text{output}}{\text{input}}$; $\text{Output} = \frac{2{,}000{,}000{,}000}{778}$ B.t.u.

$\text{Input} = 14{,}500 \times 1{,}000$ B.t.u.

$\text{Eff.} = \frac{2{,}000{,}000{,}000}{778 \times 14{,}500 \times 1{,}000} = 0.177 = 17.7$ per cent

PRACTICAL AIDS TO OPERATION

Oil Ignited in Oil Separator on Air Compressor

A 4-STAGE air compressor delivering air at 1,430 lb. pressure burned a bend in the pipe just beyond the stop valve on the discharge side of the oil separator. An examination showed that the metal of a bronze bushing and the copper ring on the stop valve had been previously melted by overheating. This caused the bend failure. The overheating was due to a temporary failure of the cooling water and ignition of the oil on the oil separator walls. After this accident, these safety precautions were taken: Better supervision of the cooling water pressure and measurement of the delivery air temperature by recording instruments. The delivery valve is periodically tested for leakage and the oil separator is cleaned at regular intervals to remove the oil film which may have formed on its surface.

Herts, England — W. E. WARNER

Capacitor Cuts Paper Company's Demand Charge $400 a Year

BY INSTALLING a 60-kva., two-phase, 60-cycle, 2,300-volt, rack-type capacitor, Eaton Paper Company, Pittsfield, Mass., received a 76 per cent return on its investment after deducting operating costs, depreciation and other charges. Considered over a 10-year period, this investment of $525 will return over $4,000.

By the terms of its power contract, this company was billed for the year according to the greatest monthly demand recorded. The monthly demand was approximately 134 kva. at a power factor of 72.7 per cent.

Generating most of its own power with a reciprocating engine, and using the exhaust steam for heating purposes, this company purchases very little power in the winter and was required to pay the high monthly demand recorded during the summer months. A survey indicated that a 60-kva. capacitor would save about $400 annually.

Schenectady, N. Y. — F. A. STORTZ, JR., *General Electric Co.*

Guard for a Right-Angle Gear Drive

WHILE all modern machinery comes from the factory equipped with guards, there are thousands of dangerously exposed old-type transmissions in mills and factories. Right-angle gears are more difficult to protect with a guard than are the usual forms of spur gears. I made a guard in four pieces for a dangerous bevel gear in the plant where I was working, as shown in the photo. This gear was located near a narrow passageway and the guard was made of the shape shown to take as little room as possible. I might add that it required a serious accident before permission could be obtained to install the guard.

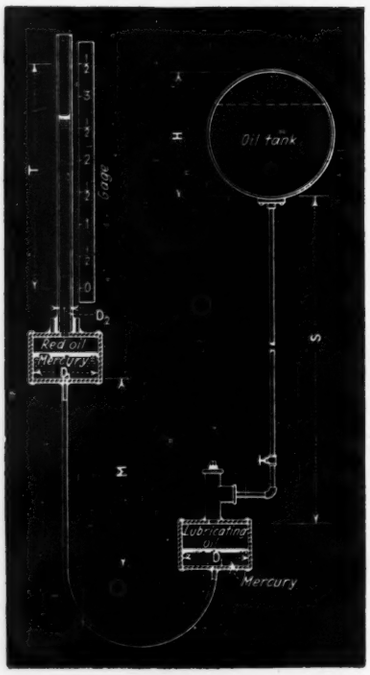
Vancouver, B. C. — S. H. COOKE

Builds Gage to Show Level in Oil Tank

THE DIAGRAM shows a liquid-level gage that I have built and installed to indicate height of lubricating oil in the supply tank. This tank is located in the boiler room about 38 ft. from the floor, and the gage is in the engine room 14 ft. above the floor, where it may be seen by anyone in the room. The gage is constructed of two similar steel cylinders, closed by welding steel plates on their ends and joined by $\frac{1}{8}$-in. steel tubing.

The lower cylinder is fitted with a plug for filling with mercury and is connected to the bottom of the oil tank. The upper cylinder has a short piece of pipe welded to it into which a gage glass is cemented with litharge.

To place the gage in operation, the lower cylinder is filled with mercury and the valve on the oil line opened. The height of oil in the tank is now measured and the gage glass filled with draft-gage oil to a corresponding height on the scale. If it is not practical to check the gage by varying the oil level in the tank, a piece of rubber tubing and a leveling bottle can be connected to the



line in place of the tank and the gage checked by raising and lowering the bottle. It is necessary that all air trapped in the line be worked out.

Any desired movement of the oil in the gage glass can be obtained between the density of mercury, 2 in. per lb. pressure, and that of the red oil, approximately 33 in. per lb. pressure. Also any static head can be balanced out by making the mercury leg the right height. The formulas given below may be used to calculate the chief dimensions of the gage.

$$D_1 = D_2\sqrt{\frac{Hd_1 - T(27.2 - d_1)}{d_2T - Hd_1}} \qquad (1)$$

Where,
D_1 = Inside diameter of cylinders in inches
D_2 = Inside diameter of gage glass in inches
H = Inside height of tank in inches
T = Desired travel of red oil in gage glass in inches
d_1 = Density of fluid to be measured
d_2 = Density of red oil

Also,
$$M = \frac{d_1S}{13.6} \qquad (2)$$

Where,
M = Height of mercury leg in inches
S = Height of fluid in inches at zero reading measured from lower cylinder

Also, to find the height of cylinders,

$$\textit{Height of cylinders inside in inches} = \frac{T}{1 + \left(\frac{D_1}{D_2}\right)^2} + \text{at least } \tfrac{1}{2} \text{ in.} \qquad (3)$$

As a specific example, take the conditions for which the gage was calculated in the figure, where.

$D_2 = 0.425$ in., $H = 42$ in., $T = 26$ in., $d_1 = 0.905$, $d_2 = 0.845$
$S = 312$ in.

$$D_1 = 0.425\sqrt{\frac{(42 \times 0.905) - 26(27.2 - 0.905)}{(0.845 \times 26) - (42 \times 0.905)}} = 2.77 \text{ in.} \qquad (1)$$

$$M = \frac{0.905 \times 312}{13.6} = 20.8 \text{ in.} \qquad (2)$$

$$\textit{Height of cylinders inside in inches} = \frac{26}{1 + \left(\frac{2.77}{0.425}\right)^2} + \frac{1}{2} = 1.13 \text{ in. or greater} \qquad (3)$$

Kansas City, Kan. ROY EMISON

Protecting Steel Plates in Coal Bunker

SOME steel plates in a coal bunker were found to have been worn badly due to corrosion and abrasion. To correct this condition and prevent further wear, the plates were first cleaned of scale and deposit by wire brushes, then a wire mesh was spot-welded to the plates. Liquid concrete composed of three parts fine sharp sand, one part Portland cement and sufficient water to give liquidity was then applied over the mesh by a cement gun. An air pressure of 35 lb. was used on the spray gun, and a coat about 0.5 in. thick was sprayed on. When this was quite dry a second application about 0.1 in. thick was sprayed to give a perfectly smooth coating.

Any type of metal plate can be protected in this way. Where a concrete spraying gun is not available, a less efficient but at the same time less expensive method of protection is to make up a concrete mixture as previously mentioned, but add sufficient water to make it thin enough to be applied by a brush. Two coats of this mixture applied to plates will give them a continuous coating. The concrete coating will have to be renewed from time to time, as the original one wears away, but a fresh coating can be easily applied.

Herts, England. W. E. WARNER.

Pulley Out of Balance Causes Sparking at Brushes

A 50-KW. direct-current generator gave trouble from sparking at the brushes. All the usual means of correcting this were tried without success. These included truing the commutator surface with a stone, adjusting the brushes, changing the brushes, checking the polarity of the field coils and undercutting the commutator mica. As a last resort, a new foundation was built for the machine, but this did not improve conditions very much.

By this time the commutator was not in very good condition. The armature was taken out and sent to a machine shop to have the commutator turned in a lathe. As the pulley was found difficult to remove it was left in place. When the armature was in the lathe it was discovered that the pulley ran about 0.1 in. out of round.

The commutator was conditioned and the pulley turned round. Since then no trouble has been experienced with sparking at the brushes. Apparently the pulley was out of balance sufficiently to cause the armature to vibrate and the brushes to chatter and spark.

Cleveland, O. C. O. PERKINS.

CURRENT COMMENT

Diesel-Electric Sets Operated in Parallel

MR. SCHAEFER'S article on a 64-diesel power plant in the May number, and the editor's comment on possible electrical difficulties prompt me to describe some of our work. We found that operating a large number of diesel-electric sets in parallel, when equipped with standard alternators, proved impractical. Synchronizing was difficult and took altogether too long a time, while the angular variation of high-speed diesels, with light moving parts, far exceeded the 3½ electrical degree limit.

Ordinary governors put out with high-speed diesels failed to divide the load between them, and it proved impossible to adjust them satisfactorily. It was impossible to avoid critical frequencies, and the general idea was abandoned, especially as the wiring and voltage control proved complicated and not satisfactory.

A successful method was finally developed, known as the Thomas-Ritchotte Power System. This consists of improved induction generators having about 3 per cent slip from no load to full load.

A-C excitation required is large in kva., but small in ampere turns. Static condensers supply the major portion and a synchronous condenser controls voltage.

A high-speed exciter and compensated windings in the condenser complete the system control. As the frequency changes 3 per cent from no load to full load, it has been found necessary to provide a method of slightly changing governor spring tension with load to increase the engine speed 3 per cent from no load to full load.

This system has proved to be very stable and satisfactory in every way. No synchronizing is necessary—just get the machine up to speed and throw a switch. Troubles from angular variations in engine speed cease to exist and the load is divided equally between engines.

Parallel operation can be maintained when the engines differ in speed by a considerable number of revolutions. In paralleling a new unit, no voltage control and no synchronizing make a simple job of having the units start and stop automatically with the load requirements.

A further development of having two-speed generators, that is a half number of poles and double speed for peak loads, and half speed for light loads, showed a way to conserve the life of the high-speed units.

The system is expensive and not practical below 450 r.p.m., but above that the cost is about the same as for standard machines.

Boston, Mass. GEORGE D. THOMAS
Instructor in Electricity
U. S. Diesel School

Variations in Draft Losses Across Boilers

YOUR leading article in the May number of *Power,* in discussing the subject of combustion control, has this statement:

"It is frequently assumed that the draft loss across a boiler varies as the square of the weight of gases being handled. There are many variables, however, such as changing direction of gas flow and temperature and possible accumulations of slag and soot, that cause this relation to be undependable."

In view of the many systems that do use this fundamental relation as a basis of boiler regulation it would seem to the interests of all concerned to permit a few comments on the matter.

In the first place while the objections stated seem plausible enough it may be conservatively stated that the experience gained from some hundreds of installations using this relation as a basis, indicates that while the boiler passes do not make a perfect metering orifice, partially because of turbulent gas flow as stated, nevertheless they do provide a means of measuring combustion air which is well within any reasonable limit of accuracy.

As for the possibility of error by reason of soot and slag accumulation, may it not be assumed that any operator who is sufficiently interested in saving fuel and improving general plant operation to install combustion-control apparatus, may also be depended upon to keep the heat-absorbing surfaces clean, the setting tight and the baffles in good repair.

There is still another objection frequently heard in the past to using these metered relations as a control basis and that is that the respective flow of air, steam and fuel may not follow similar parabolic curves, so that at different points on the curves the desired relations may not exist between them. In most modern systems it is now possible to anticipate this difficulty by building in various adjustments into the different regulators so that their characteristics may be changed to suit the requirements of each individual boiler as encountered in the field.

To summarize: This article cites the variation in flow of gases which may attend the same differential pressure owing to a change in the conditions within the boiler as an objection to using the measurement of gas flow as a basis for boiler regulation. Is it not reasonable to expect that any position regulation determined by observation at a given time is equally or still more subject to the same sort of variations?

Stoneham, Mass. WILBUR F. PRAY

[Reading the paragraph following the one to which Mr. Pray takes exception makes it evident that Mr. Davis, author of the article, had no intention of condemning automatic combustion-control systems of any kind, nor the principles on which they operate. He calls attention to certain possible sources of error in them and then says: "In order to proportion fuel and air properly with the combustion-control system, tests on the boiler were made to determine the proper adjustments." Rather than condemning the system in any way, he places the stamp of 100 per cent approval on it, as is clearly indicated in his summation, given in the next-to-last paragraph of the article.—*Editor.*]

Insulation Resistance Should Be Above One Megohm

I READ with interest the answers to the question on insulation resistance in the May number and would like to add a few comments. Good insulation on electrical

power-plant equipment will test 50 megohms or better. While a safe insulation test will range from one to 50 megohms, below one megohm and down to 0.5 megohms, a close check should be kept on operating conditions and on the insulation until such time as it is convenient to take the machine out of service for a thorough cleaning and then varnish the windings.

If, when the insulation tests between 0.5 and one megohm, the equipment is allowed to operate at an overload for a considerable length of time, an insulation breakdown is likely to occur.

Insulation that has a resistance below 0.5 megohm should be repaired at once either by cleaning, baking, reinsulating or rewinding.

There is little danger of going wrong by accepting the A.I.E.E. standard on insulation resistance. Of course, like most other rules, its application must be governed by good judgment and an understanding of local conditions.

It is a good plan to make insulation tests at least twice a year and then increase the frequency of the tests as the resistance of the insulation decreases.

When a machine is taken out of service, loose dirt and dust should be blown out with compressed air, then the winding should be sprayed with gasoline, or better still, carbon tetrachloride. With the latter, there is no fire or explosion hazard.

After the windings have been thoroughly cleaned, they should be allowed to dry, then an insulation test should be made. If the reading is still low, the machine should be baked at about 200 deg. F. until the insulation tests preferably above 50 megohms. This may require several hours of baking or it may take several days, depending on the amount of moisture in the insulation and the ventilation of the oven.

If after drying at about 200 deg. F. for several days there is very little improvement in the resistance readings it would be best to consult the manufacturer or open the winding and test it in sections to see if the low resistance is concentrated in a few coils. If there is an improvement, even though small, at each test, which should be made about every 10 hr., continued baking at a safe temperature will produce the desired results.

When the insulation shows high enough resistance, the windings should be painted or sprayed with a good insulating varnish, then baked. The time necessary for baking will be stamped on the varnish container by the manufacturer. The equipment should be given at least two coats of varnish before being put back in service.

A 500-volt megohm meter may be used on a 6-volt generator to test the insulation without causing damage.

Burlington, N. J. RUSSELL W. EDWARDS

I WOULD like to submit the following comments on the answers to the insulation-resistance question in May number:

I am maintaining several thousand horsepower in electrical motors and generators under yearly contracts and I use a 500-volt megohm meter on all equipment under 750 volts. Although a minimum of one megohm is set for electrical resistance, any resistance down to 0.25 megohm is satisfactory if this value is maintained without further drop. Tests are made every three months and a record kept. If a machine shows a large drop in insulation resistance, it is tested weekly until its trend is learned. If it keeps dropping, the machine is taken out of service, dried out and varnished. If this does not remedy the trouble the machine is rewound. High-voltage tests are made only on new and newly rewound machines. This method has proved very satisfactory, and we have had no avoidable shutdowns since these practices have been followed.

Ellenville, N.Y. COURTLAND VAN GORDER

Are 64 Diesels in One Plant Practical?

MR. SCHAEFER'S proposal (*Power*—May, 1934) of a battery of 64 high-speed diesels of 100-hp. rating in a plant is indeed a startling departure.

Personally, I do not believe the development of the high-speed diesel has yet reached a point where a many-unit small high-speed diesel plant can compete economically with more conservative designs, except possibly for very special power applications. However, I am open to conviction and welcome any criticism of my objections to the high-speed plant.

Unfortunately, Mr. Schaefer gives no estimates of first cost of small-capacity, high-speed diesel units on a quantity production basis of manufacture or estimates of total first cost of a 64-unit, 6,400-hp. plant so equipped. In attempting to analyze his proposal, I inevitably get back to this question of complete plant first cost, upon which it appears the economic possibilities of such a design may largely depend.

If connected to generators, and except for a few special applications, this would appear to be the only practical arrangement in a plant of 6,400 hp. installed capacity, engine speed for 60-cycle current would be limited to 1,200 and 1,800 r.p.m., presumably the latter to take advantage of the ultimate possibilities of high speed and low first cost. For 25-cycle current, 1,500 r.p.m. would be the only choice, while for direct current any speed best suited to the engine might be utilized.

An engine with a 6-in. stroke turning 1,800 r.p.m. has a piston speed of 1,800 ft. per min. At 1,500 r.p.m., the same engine would have a piston speed of 1,500 ft. per min. An engine with 5.5-in. stroke at 1,800 and 1,500 r.p.m. would have piston speeds of 1,650 and 1,375 ft. per min., respectively. These piston speeds are far in excess of present-day accepted practical maximums for continuous heavy-duty power service. Such piston speeds are comparable to those of aircraft motors good for some 200 to 300 hours of normal operation between overhauls and with a nominal life of 2,000 to 3,000 hours.

Of course the high-speed stationary diesel is a much more rugged machine than the high-speed aircraft motor in which much is sacrificed to secure minimum weight. But, too, operating conditions for a stationary engine under full-load, full-speed continuous service are much different than for a similar engine in a truck, tractor or shovel where the periods of rated full load or overload and full speed are frequently of short duration. For stationary high-speed diesels under continuous full-load and full-speed operation, 2,000 hours between top overhauls, 4,000 hours between ring renewals and 8,000 hours between general overhauls appears too optimistic. I should be interested in authentic records of such performance.

The first cost of small high-speed alternators (1,500-1,800 r.p.m.) on a quantity production basis would probably be less than an equivalent capacity in slow-speed alternators (180-360 r.p.m.). Individual exciters would not be necessary or even desirable; the entire 64-unit excitation could be more advantageously supplied by

three or four exciters driven by engines duplicates of the main power units. The efficiency of the many small alternators would be less than that of equivalent capacity in a few slow-speed units, which sacrifice in alternator efficiency might be partially offset by the greater flexibility of the many-unit, high-speed plant permitting all machines in use to operate under practically full-load conditions.

The first cost of switchboard and control equipment and the space necessary for its installation would be a major item in the many-unit, high-speed plant, unless a radically different design of switchboard than dictated by present practice could be developed. It would be virtually impossible to intelligently and economically operate the many high-speed units in synchronism without substantially the same essential switches and instruments that are necessary for each unit in other plants. And for safety, the main switches, in spite of the small capacity of the individual units, should have interrupting capacity equivalent to the total plant capacity.

Floor space for the 64 high-speed units and the height of the building might possibly be less than for the conventional plant of equal capacity. But any advantage of reduced floor space would be partially, if not wholly, overcome by the greatly increased space requirements for the switching and control equipment. Operating difficulties with 58 small units in synchronism would depend largely upon the elaborateness of the design of plant and control equipment. With proper equipment, these difficulties should not be insurmountable. But unless designed for wholly or partially automatic operation, all of which increases first cost, fully as many and probably more attendants would be required for the high-speed plant than for the equivalent low-speed plant.

Foundations, a major item in the slow-speed plant, would be practically eliminated in the high-speed plant unless, perchance, the small units were arranged in tiers. But here again this advantage would be partially offset by the proposed individual soundproof housings and common ventilating system. Cooling problems would probably not differ materially in the two types of plants nor should the lubrication problem or cost.

In fuel costs there may be a vast difference between the small-unit high-speed and the large-unit slow-speed plant. Fuel consumption of 0.45 lb. per b.hp.-hr., Mr. Schaefer states, can readily be obtained in the small-capacity high-speed units. In the large-capacity slow-speed units, a fuel consumption of 0.41 lb. per b.hp.-hr. is common. This is not a great difference, but in the present state of their development it is doubtful if the high-speed small-capacity units will successfully operate on fuel heavier than 32-36 Bé. or what is marketed under the trade name "gas oil." On the other hand, a large unit slow-speed plant of above 5,000 hp. installed capacity would probably use fuel in the range between 18-24 Bé. or even heavier because of the favorable price differential.

Neglecting the item of transportation, which is the same for either fuel, when 32-36 Bé. gas oil sells at the refinery for 3c. per gal., $1,26 per bbl., 20-22 Bé. diesel fuel sells for about $.55 per bbl. There is little difference in the heat value per pound of the two fuels, but if the small high-speed units must utilize the lighter fuel, there would be a profound difference in annual fuel costs for the same plant output.

Assuming a maximum plant load of 5,800 hp. and a load factor (referred to max. load) of 43%, the annual plant output would be approximately 21,900,000 b.hp.-hr. For the small-unit high-speed plant requiring 0.45 lb. of 32-36 Bé. fuel per b.hp.-hr., fuel consumption annually would be approximately 31,280 bbl. costing $1.26 per bbl., making a total cost of $39,400. For the large-capacity slow-speed unit requiring 0.41 lb. of 20-22 fuel per b.hp.-hr., fuel consumption annually would be approximately 27,550 bbl., costing $0.55 per bbl., making an annual fuel cost of $15,150—a difference in favor of the large capacity slow-speed plant of $24,250 annually in fuel costs. Even penalizing the slow-speed large-capacity units because of the lesser flexibility of the plant and assuming a fuel consumption of 0.45 lb., the same as for the high-speed units, the annual fuel saving for the large units is $22,700.

A slow-speed plant consisting of, say, seven 1,000-hp. units, or six 1,200-hp. units, or five 1,400-hp. units, or four 1,800-hp. units could be built at a total cost of approximately $500,000.

In such a plant under load conditions, such as are assumed in the hypothetical plant under consideration, the total maintenance cost of the complete plant, engines, electrical equipment and auxiliaries could reasonably be expected over an extended period of time to range from $1.50 to $2 per yr. per hp. of installed capacity. Using the higher figure of $2, annual plant maintenance expense would be approximately $14,000. This total applied to Mr. Schaefer's proposed 64-unit plant would mean an average maintenance expense of $220 per unit annually. Whether it would suffice is problematical, and may never be known until small-capacity high-speed stationary diesels are actually applied to continuous, full-load, full-speed, heavy-duty service.

Capitalizing the difference in fuel cost alone in favor of the large-unit, slow-speed diesel plant would indicate the first cost of the small-unit, high-speed plant must be much less than half the cost of the former to be economically competitive.

Oklahoma City, Okla. J. H. BENDER

A Steam Experiment

BEING very much interested in steam, I tried an experiment by filling a 50-gal. oil barrel with a pail and a half of water, probably covering its bottom about 3 in. I then put the heavy barrel out in a field and built a fire under it, tightened the threaded plug, and waited to see what would happen. In about 7 min. one head started to leak, and then in a moment it exploded with a noise as terrific as a dynamite blast. There is quite a hill just above the spot where I built the fire, but the drum went up over the hill, striking the ground about four times. In all, it traveled about 225 ft. from the fire. The head that blew out went the other way about a third of that distance, tearing up the earth, and lodging against a large bush. The head still in the barrel was bulged out also.

How much steam pressure was built up before the barrel burst? I work in a steam plant and would very much like to know. In our plant we have two Cunningham boilers 18 ft. 4 in. long with through stays and $\frac{3}{8}$-in. shell. We carry 100 lb. pressure. Could anyone tell what would be the bursting pressure on these boilers today? No defects are noticeable, beyond a little scale on the tubes. I would be pleased to have these questions answered if it is possible.

West Swanzey, N. H. ROBERT WOODS

READERS' PROBLEMS

QUESTIONS for Our Readers

QUESTION 1

WE HAVE *three pulverized-fuel-fired boilers which supply steam at about 250 lb. pressure and 650 deg. to our turbine room. The boilers are operated to maintain drum pressure as nearly constant as possible, and only enough below the safety valve setting to prevent popping off on sudden load decrease. This of course means that the pressure in the steam header varies with the boiler output, because of the pressure drop in the superheater and piping. Other plants, we understand, operate to maintain constant pressure in the steam header. What, if any, is the advantage of this latter method of operation? Will either method influence turbine-room performance?*

—A. A. F.

QUESTION 2

WE ARE *considering installation of a 300-kw. engine in our factory, to be operated on 150-lb. steam purchased from a neighboring plant about 100 ft. away. Steam is to be paid for at a certain rate per 1,000 lb. but we understand that all flow meters will read high because of the pulsating flow caused by the steam engine. What can be done to minimize this error? Will installation of an oversize steam line or receiver help?*—G. R. R.

Suitable answers to these questions from readers will be paid for if space is available for their publication.

Olden Days

I WAS *very much interested in "The Story of Power" in the June number. Can you suggest books that will give me a more detailed story of the earliest days of development of steam engines and of gas and oil engines?* —K. B. B.

A fine source for data on the earliest steam engines and their builders is Stuart's famous "Anecdotes of Steam Engines," printed in 1829 and now exceedingly rare. The libraries of larger cities may possibly have it, or reprints of it. Most later works are based on this. If you fail to find a copy of Stuart, try Thurston's "The Growth of the Steam Engine." Early days in gas and oil engine development are covered completely in "Oil and Gas Engines" by Dugald Clerk, inventor of the 2-stroke cycle.

GEAR DRIVES WEAR RAPIDLY

ANSWERS to May Question 1

THE QUESTION

WE HAVE *several gear drives that give trouble and get noisy from rapid wear. To remedy these difficulties, a change to non-metallic pinions is being considered. If this change is made, will it be necessary to use gears and pinions with wider faces than those of the present gears? If so, how much wider? The load is very irregular. I would also like to have* POWER *readers' opinions of the possibility of this change proving a cure for the trouble?*—L. R. S.

Recommend Using the Correct Lubricant

THE trouble is probably due to incorrect adjustment and alignment, unsuitable lubrication, or possible lack of lubrication.

No matter how well gears may be designed, constructed and installed, they must be correctly lubricated. If the gears in question are enclosed and provided with either a bath or circulation system of lubrication, suitable oils are available to meet conditions. If the gears are open and exposed, then the usual bearing lubricating oils will not suffice, because they will not "stay put" when applied by hand. The same is true of ordinary greases which soon squeeze out and leave metal-to-metal contact that will cause wear and noise.

There are products obtainable, however, that are entirely suitable to lubricate the teeth of open gears. These have an extremely heavy body so that they must be applied hot. Application of these products at frequent periods builds up on the tooth surfaces a coating that is not easily squeezed out and also cushions contact between the teeth and produces quiet running, with almost negligible wear. I have used these products on noisy gears with satisfying results over a period of years. Possibly L.R.S. might try to correct the lubrication instead of changing gears.

Brooklyn, N. Y. CHARLES J. MASON

Get the Oil and Gear Manufacturers' Opinions

THE question is hardly specific enough to enable one to give a definite answer. If the gear size, pitch, speed, metal used and power transmitted were known a solution could be found. The larger oil companies employ staffs of lubrication engineers. Someone on each staff will be qualified to pass an opinion as to whether or not the gears have the right lubricant. Most oil companies have developed a line of extreme-pressure lubricants, and possibly a gear lubricant of this type would eliminate some of the wear and extend gear life. In many instances, selection of the right gear lubricant has more than doubled gear life.

If the gears are of the ordinary cast-iron variety, it may be advisable to change to ones made from a special metal, such as cast iron with a small percentage of nickel. Many 150- to 250-hp. electric motors are equipped with forged, heat-treated steel pinions, some of which have been in constant service for over ten years driving heavy and irregular loads. In such service, non-metallic pinions would have given very short life.

I would suggest that an engineer from a larger oil company and one from a reputable gear manufacturer be asked to visit the plant and render an opinion as to what causes the rapid wear of the gears.

New York, N. Y. W. P. LAMBERT
Lubricating Oil Department
Standard Oil Company of N. Y., Inc.

Has Had Long Experience With Non-Metallic Gears

THE non-metallic pinion should be slightly wider than the metal gear. An eighth or quarter of an inch is generally sufficient. This is especially true if the pinion is made with metallic flanges, as they often are, for holding the non-metallic laminations together. I have had nearly 25 years of experience with non-metallic gears and find that they are in general satisfactory.

M. M. GOOCH
Atlantic Highlands, N. J.

Suggests Several Remedies for the Trouble

THE fact that L.R.S.'s gears get noisy and wear rapidly plainly indicates that the present gears are either not made of the right material of the proper form, are too small in face or pitch, are not properly lubricated, are exposed to abrasive materials or are mounted on shafts that are not sufficiently stiff. If the gears are cast iron, they may be replaced with non-metallic gears of equal size. If steel gears are used, then the face width of the non-metallic pinion and its mating gear will have to be increased.

If the present gears are open and can be enclosed and run in an oil bath, this probably is all that will be necessary to correct the trouble. If the gears are loosely enclosed and lubricated with a dirt-collecting gumbo mixture of grease or oil, as many gears are, the probable remedy is to make the case oil- and dust-tight and lubricate with a high-grade oil, using a light oil for high-speed and a heavy oil for low-speed gears.

If not supported by bearings close to the gear hubs, the shafts may spring and cause destructive hammering of one gear upon the other, especially with variable

loads. The remedy is a larger shaft or bearings close to the gears. If neither is feasible, a non-metallic pinion will help. In one case of a hoist, substitution of a mortise maple-tooth gear for a cast-iron one on a limber shaft cured trouble where a $500 gear was wrecked about every six months.

Reputable gear makers, if provided with complete data on the present drives will be glad to make recommendations, but it may be necessary to consult more than one to find just what is wanted.

Kendalls, Wis. IRA A. BUTCHER

Install Silent-Chain Drive

IF GEAR drives are to operate noiselessly and last a reasonable length of time, they should be selected carefully for the job, be properly installed and checked for alignment and clearances after being put into operation. The most common causes of noisy or rapidly wearing gears are too high speed for the type of gear, too much load for width of gear face, shafts out of line, irregular loading (which causes back lash and rebound), gears meshed too tightly. Gear teeth are cut so that their action in mesh is rolling, rather than rubbing, and a side clearance of from 0.002 to 0.003 in. and a bottom clearance of approximately 1/10 the height of the tooth should be maintained.

The fact that the gears were quiet when first installed and later became noisy, as implied by L.R.S., indicates that the load is too great and the speed too high for the width of face. Unhardened metal pinions wear rapidly at peripheral speeds of 1,700 f.p.m. and over. Non-metallic gears find their best application at high speeds. They cushion the shock and are therefore less noisy. According to the Lewis formula for gears, rawhide teeth should have 1.5 times the width of cast-iron ones and 3 times the width of teeth made from 0.3 carbon steel for transmitting the same power.

For best results, new gears should be used with new pinions because gears with worn teeth would soon ruin a new pinion. Satisfactory results should be obtained if the directions given above are followed. A considerable number of spur gear drives are being replaced by silent chain drives which are higher in first cost, but are justified by their long life, low maintenance, and trouble-free operation.

Waynesboro, Va. J. M. MYERS

Diesel Noise and Vibration

ANSWERS to May Question 2

QUESTION 2

TWO 150-HP. *diesel-generator sets on poured concrete foundations without isolation supply power for our factory. We have just rented space on the floor over the engines, and the new tenants object to the noise and vibration of the engines. What is the best and cheapest way to eliminate the trouble?*—P. T. N.

May Have to Strengthen Floor

AS A rule solution of a problem of this character should offer no particular difficulty, but it requires a careful mathematical analysis. The information required is:

1. Complete specifications of the diesel as to size and stroke of engine, revolutions, number of cylinders and also primary and secondary unbalanced forces. All this information is easily obtainable from the manufacturer.

2. Size of the concrete foundations and arrangement of foundation on the floor.

3. Full information on floor construction to be able to determine the natural frequency of the floor construction. This is of great importance in order to avoid possible resonance conditions.

On the basis of the information obtained and mathematical analysis it will probably be recommended that an isolating material be placed between the engine foundation and the floor. Such isolating material may be made of any organic or inorganic material. There are a number manufactured which, depending upon conditions of application, have proved satisfactory. In my own experience, I have found that for problems of this character, especially for engines running at a fixed speed, steel springs will probably give the most satisfactory results. It may also be necessary to strengthen the floor. It is obvious that under no condition must the resiliency of the floor be greater than the resiliency of the isolating medium between floor and engine foundation. The resiliency of the isolating material has to be kept within a reasonable limit, as otherwise satisfactory operation of the engine, with its piping connections, is not obtainable; therefore, a floor of great rigidity is required.

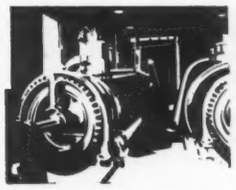
New York, N. Y. S. ROSENZWEIG
Consulting Engineer

Change Engine Speed

IF THE objectionable noise arises from vibration in the engine itself or in the building, it is possible the normal rotative speed of the engine is near a "critical speed" for the particular unit. Or if the vibration of the engine itself is not excessive, it may be of a frequency approximating the period of vibration of some portion of the building.

In either case a slight change in rotative speed, even as little as 5 per cent, might have a marked effect. Whether to increase or decrease can only be determined by trial. Where engines are connected to alternators, it may not be practical to change the engine speed because of the change of frequency of the current generated. Where connected to d.c. generators or belted to the load, a moderate change in engine speed should not be troublesome.

A frequent cause of objectionable noise with 2-cycle engines is the pulsation of the scavenging air pump, which may set



up harmonic vibrations in structures at considerable distances from the engine. The remedy, as well as for noise from the exhaust, is obviously effective muffling. Extreme cases of inherent engine vibration may be overcome only by isolation of the engine foundation from the building walls, foundations and floors.

Oklahoma City, Okla. J. H. BENDER

Call a Consultant

VIBRATION and noise are the same thing, in other words, if P. T. N. can eliminate the vibrations or most of them he will have a quiet engine room and engines. Exhausts and air intake lines may be muffled with Maxim silencers. Damping of the vibrations caused by the engines will be a harder job, as the engines are already installed. First, see that the foundation does not come in direct contact with the foundation of floor of the building. Second, install flexible pipe between engines and building walls where the pipes anchor to the building or pass through the walls. Units of this size are probably too heavy to place on a cork mat on top of the foundation; a spring suspension will handle them.

The cheapest way out of the trouble seems to be to retain an engineer to make tests of the vibrations and their causes and have him recommend the proper remedy.

Walthill, Neb. WM. W. DINGWALL
Chief Engineer,
Walthill Power Station,
Central States Elec. Co.

Redesign Set-Up

EITHER of two methods can be used to reduce the vibration set up in the building by the two engines. A layer of cork or a thick layer of pitch could be placed between the foundations and the floor. This provides a cushioning effect and tends to dampen the vibration set up by the engine. This is very effective and is practiced in many installations, is inexpensive and does not require a lot of time. One engine can be changed while the other is kept in operation. A second method is to set the engine supports on live rubber mountings. This is cheap but not very effective.

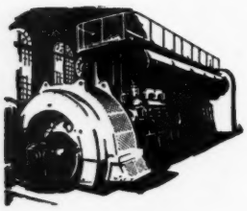
In order that the engines may run quietly, all moving parts, such as bearings, pistons, valves, gears, etc., should be properly adjusted or replaced to compensate for wear. If the valves are noisy, this may be reduced by using two small valves instead of one large one.

An exhaust muffler should be provided to dampen exhaust noises. An effective and cheap muffler is an enclosed concrete pit beside the engine foundation. Exhaust enters at the top of the pit, near one edge, inclined slightly from the vertical. The gases are carried out by a stack perpen-

dicular to the top of the pit. Edges of pipe and stack are flush with the inside top edge of the pit. A small pipe nipple at the bottom carries away water of consensation which is created by combustion of hydrogen.

The noise of the intake manifold may be silenced by means of an intake silencer. A large cast-iron elbow, slightly larger than the intake, is placed over the air intake manifold entrance. A thin-walled brass or aluminum pipe with 1/32-in. milled slots is placed on the elbow. The slots should stop within 14 in. of the elbow. A cap is placed over the pipe to keep out foreign matter. To prevent throttling the area of the slots should be about two times the area of the pipe cross-section. Diagrams of this intake silencer and exhaust stack can be found on page 329 and page 332 of Maleev's "Internal Combustion Engines" (McGraw-Hill).

Gettysburg, Pa. KARL J. BERNHARD
Student M.E.,
Gettysburg College



Inlet, Exhaust, Injection?

NOISE may be caused by the air inlet. This may be muffled by connecting the inlet to an air duct in the floor or to a standard muffler such as is used to eliminate exhaust noises. Noise caused by the exhaust is best handled by leading the exhaust pipe into a brick or concrete chamber with one or more outlets, or the usual discharge pipe led to a level somewhat higher than that of the roof. If the noises are mechanical, proper adjustments will help to quiet that trouble. Too early injection will cause the engine to pound and cause vibration. There is only *one proper injection setting.*

Assume that the above does not cause the trouble. Then there is one other cause —the foundation is too light or the subsoil is not suitable. A proper start should be to drive piling to anchor and support the load and absorb the vibration.

Suitable matting under the present engine bed has been successfully used to absorb vibration. A foundation expert can solve the latter problem.

Cleveland Heights, Ohio.
JAMES MCINTOSH

Cut-and-Try Procedure

SOME member or members of the building structure are being caused to vibrate at the points where their vibrations will be greatest and therefore cause the greatest amount of noise and annoyance. Complete isolation of engines and foundations from the building would eliminate the trouble, but this is expensive. There is probably some particular part of the building over the engines that is transferring most of the vibration and noise. Find that place first—its location will depend a great deal upon the type of building.

If the second floor flooring is of wood, it may be that renailing more securely may lessen vibration decidedly. If the trouble is the supporting members, they may have to be braced or made heavier. Pipe lines, electric conduit or other connecting lines leading to an upper floor may be your chief source of trouble. These can be isolated with spring mountings. In any case, it is a matter of cut-and-try. Unless you isolate the engine foundation, you won't eliminate the trouble, but these other methods will at least reduce the nuisance considerably.

High Point, N. C. A. W. DUNBAR

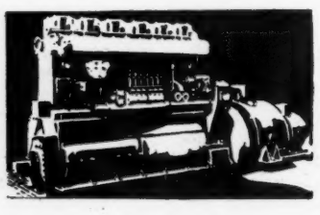
Use Lead Mats

WE HAVE a similar problem. Two engines of the same make stand within 25 ft. of each other in the Newberry Village Water & Light Plant. The 3-cyl. unit causes no trouble, but the 2-cyl. engine vibrates the powerhouse and buildings ⅜ mi. away. Two possible causes include unbalanced forces in the 2-cyl. unit being transmitted through the veinous quicksand-filled water courses underground or that both engines are equally well balanced and the 2-cyl. unit happens to be nearer an underground watercourse.

If the first problem is causing P. T. N.'s trouble, the manufacturer is interested. If the second exists, piling must be driven down through the watercourse into hard bottom to support a heavy mat on which engines and pumps or alternators should be mounted.

If neither of these things is causing trouble, adjacent floors and walls may be absorbing engine vibration by direct integral connection with the engine foundation, causing vibrations in unison or in harmonic synchronism in columns, walls and floors above. The remedy is to increase foundation mass or weight, isolate engine and foundation, or increase foundation area.

Noise is most likely transmitted via the foundations, and can be reduced by using a sound-resistant material such as lead between engine and foundation and between foundation and floor and walls. The required thickness of this mat can be estimated by standing on pads of various thicknesses near the engine, noting intensity of both sound and vibration. If noise or vibration cannot thus be reduced, they are transmitted by air, and acoustic materials must be placed around the engine or on the ceiling. If noise and vibration are reduced, then the thickness of pad required must be gauged by the objector's sensibility. He has a right to require only such reduction as is necessary for his and his friends' comfort and health. Thus, take pads into the objector's rooms and find which thickness eliminates his objections when he stands on them in his apartment. Then stand on the pad he selects and see if the noise is reduced as much as it was by the thicker pad you selected near the engine. If it is, the thicker pad is correct to use under the engine. Suppose 1 in. of lead at the engine gives the same effect as ¼ in. in the objector's room, which is 100 ft. distant, measured the shortest way across engine-room floor, up walls, and across ceiling. Check intermediate points for noise. The thickness of pad should be, at any point t_x, determined from $t_x^2 : 1^2 = 1/c^2 : 1/(c+x)^2$, in which c is the distance from the engine's center of vibration to the 1-in. pad and x is the distance from the 1-in. pad to the place where vibration is to be suppressed, measurement being made as before along conducting planes.



Possibly the walls or other conducting masses are too light in weight, and buttressing or counterfooting a wall will be the simplest way to cure the trouble. I have a sketch of a compressor setting in which vibration is almost nil, although it appears as if it should be very great, for a concrete-filled 6-in. pipe 10.5 ft. long supports the floor under the base.

Newberry, Mich. R. R. RYAN
Civil Engineer

Tighten Up

ENGINE and generator should first be gone over. It is quite possible that the engine is not correctly balanced, the shaft is out of line or the set is not firmly bolted to the foundation. If the noise is from the engine, then there may be loose bolts in connecting and piston rods, valve stems, etc. Go over all and tighten them up. Should the noise come from the exhaust, this can be overcome by a suitable muffler. Try running the set at different speeds, and find out the critical speed, as perhaps it corresponds with that of the building, resulting in excessive vibration. Select a speed either under or over the critical. Should the vibration and noise still continue, call in the builder of the set, and also consider placing lead, asbestos, rubber or cork between the concrete foundation and the set. Companies in a position to give further particulars and prices are: Johns-Manville Co., American Hard Rubber Co., and Armstrong Cork Co., all with offices in New York.

CHAS. H. HUGHES, *Engineer*
New Dorp, Staten Island.

3-in. Lead Blocks

ONE suitable method of dampening the noise and vibration is to insert lead blocks or strips about 3 in. thick and the width and length of the foundation plates of the engine. While this is a cheap and rather satisfactory method, these lead inserts must be included in the regular engine inspection and must be kept tight to prevent them from pounding out. It would be advisable to suspend the exhaust piping on spring-type hangers. If the engines have no mufflers, they should be supplied. If the plant has a brick smoke stack, that would make an ideal muffler for both engines.

Midlothian, Ill. T. W. DECAMP

THE ENGINEER'S BOOKSHELF

Power Transmission

FIFTY REPORTS ON MECHANICAL POWER TRANSMISSION FROM MOTOR DRIVE TO INDUSTRY—*By Robert W. Drake. Distributed by Engineering Committee of the American Leather Belting Association, through J. R. Hopkins, 113 North Green St., Chicago, Ill. Paper; 225 pages, 8½x 11 in.; tables; 123 illustrations.*

One of the greatest needs of the mechanical power transmission industry has been better information on which to apply equipment intelligently. This book goes a long way toward supplying that need. Written in the form of 50 reports, it covers a wide range of subjects pertinent to the application and care of mechanical power-transmission equipment. Of the many useful things in the book the six tables for the selection of belts for motor drives are probably most outstanding. These tables include most conditions encountered in open-belt applications.

The author's long experience in power applications has well fitted him to write on the subject. This book should do much to put mechanical power-transmission applications on a more satisfactory basis, as it emphasizes the necessity of using equipment large enough for the job, something too frequently neglected.

Instruments

DESIGN AND USE OF INSTRUMENTS AND ACCURATE MECHANISM (1934). *By Thomas North Whitehead, assistant professor of Business, Harvard Graduate School of Business Administration. Published by The Macmillan Co., 60 Fifth Ave., New York, N. Y. 283 pages, 5¾x 8½ in. 85 illustrations. Indexed. Cloth. Price $3.50.*

Written for those who design or use accurate mechanisms and instruments, thus appealing to designing engineers and practical scientists. The author's somewhat novel analysis of the functioning of accurate mechanism results in systematic consideration of the principles underlying its design and use. He draws on his experience as a designer and user of instruments and mechanism to analyze the actual physical causes of inaccuracy, and to consider these in relation to practical problems of design and use. He gives a variety of instances and illustrations.

Power-equipment designers will be particularly interested in the book if they are required to design carburetion, injection and ignition elements in internal-combustion engines, or automatic and hand controls and auxiliaries for any power-plant equipment.

Arch Dams

ARCH-DAM INVESTIGATION, VOL. II—*By Engineering Foundation Committee on Arch-Dam Investigation and Sub-Committee on Model Tests. Published by The Engineering Foundation, 29 W. 39th St., New York City. Cloth; 542 pages, 6x9 in.; 177 illustrations; 66 tables. Price $3 to members of the founder societies, $4 to non-members.*

During 1927, the Bureau of Reclamation, in cooperation with Engineering-Foundation Arch-Dam Committee and the University of Colorado, began a comprehensive program of experimental work on small-scale models of arch dams. The purpose was to supply definite information regarding the safety of arch dams built and under construction by the Bureau, to check the trial-load method of designing arch dams developed by the Bureau, to demonstrate the feasibility of using small-scale model tests in planning costly arch-dams; and to provide the complicated technical data needed for comprehensive engineering studies of deformation and stress distribution, particularly in Boulder Dam.

This report covers the work done in testing small models of the Stevenson-Creek Test Dam and the Gibson Dam, together with the auxiliary tests of concrete specimens made in connection with the tests.

N.R.A. Handbook

A HANDBOOK OF N.R.A. (2ND EDITION)—*By Lewis Mayers. Published by Federal Codes, Inc., New York and Washington. Cloth. 842 pages, 6x9 in. Price, $6.50. ($10 with semi-monthly supplement service to Dec. 31, 1934.)*

While called the *second edition* of "A Handbook of N.R.A.," this volume is practically a complete new work. Its 844 pages contain only 250 pages of matter that appeared in the old book, and these are reproduced in the present work chiefly in the appendix.

This volume is "an analysis and compilation of the National Industrial Recovery Act and related statutes, federal and state, and of all executive orders, regulations, agreements, administrative rulings and judicial decisions relative thereto; together with a comparative presentation of typical provisions of the several codes of fair competition, the texts of the principal codes and summaries of all minor codes."

In the bulk of material contained, the book is somewhat forbidding, but less so than the tons of material which have been printed on N.R.A.

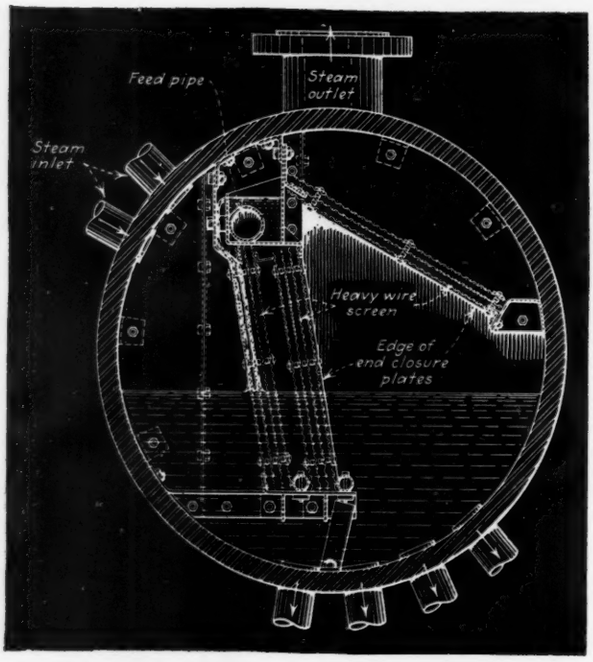
BRIEF REVIEWS

MITTEILUNGEN AUS DEN FORSCHUNGSANSTALTEN DES GUTEHOFFNUNGSHÜTTE-KONZERNS (RESEARCH REPORTS). *Published by V. D. I.-Verlag, Dorotheenstr. 40, Berlin, N.W.7. 22 pages, price 2.45 reichsmarks.*—This publication comprises three monographs. The first, by Stephen Hofer, is a study of the flow in modern steam turbines, as a guide to design. It discusses the relation between efficiency and length of blade, and the influence of the angle of entrance on friction loss. Wetness of steam in the low-pressure stage causes braking and erosion. Methods are discussed for minimizing these objectionable effects. The second paper, by K. Poll, describes a new type of two-stage rotary compressed-air motor, with illustrations. Several of these motors are stated to have been in successful operation for some time. Indicator diagrams are shown. The third paper, by Walter Lindner, discusses recent progress in building large gears.

TECHNISCHE TABELLEN, (TECHNICAL TABLES). *Published by the Robert Bosch A.-G. through V. D. I. Verlag, Dorotheenstr. 40, Berlin, N.W.7. 184 pages. Price 1.60 reichsmarks.*—This little vest-pocket volume—its dimensions are only 3x4½x¾ in.—contains a suprisingly large amount of data. Though compiled primarily for automotive engineers, it will find wider use. Space permits merely an indication of some of the items—units of various kinds with their symbols and names in German, English and French; conversion factors; formulas in mechanics and hydromechanics; definitions and units of electricity and magnetism; properties of numerous solids, liquids and gases, including some not commonly listed; composition of alloys. About half the book is a very terse discussion of motor-vehicle performance, adjustments, care and remedies for faulty functioning.

STRÖMUNGSGESETZE IN RAUEN RÖHREN (LAWS OF FLOW IN ROUGH PIPES). *By J. Nikuradse. Published by V. D. I. Verlag, Berlin N.W.7, Germany. 22 pages, 21 illustrations. Price 5.00 reichsmarks.*—This appears as Research Bulletin No. 361, of the Verein Deutscher Ingenieure. The present research was undertaken to investigate the influence of varying degrees of roughness over a wide range of conditions. Means were devised for obtaining definite ratios of surface irregularity to tube diameter. Grains of sand, screened between narrow limits, were made to adhere with thin varnish. Measurements were made of pressure drop, distribution of efflux velocity, quantity of flow and temperature of the water. Pressure was measured by means of Pitot tubes. In his analysis the author makes frequent reference to "Reynolds numbers," a direct function of mean velocity and tube diameter and an inverse function of kinetic viscosity. He finds that when this number is small, the resistance is the same as in smooth tubes, but that this does not hold true for high values. Finally a formula is developed for the distribution of velocity with reference to the distance from the wall.

WHAT'S NEW IN PLANT EQUIPMENT



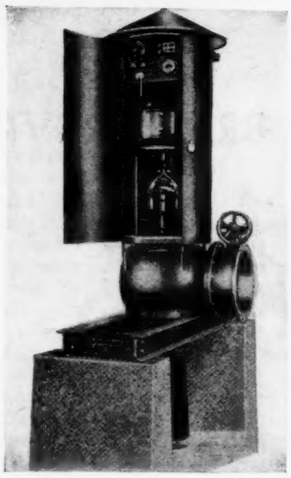
Steam Washer

To reduce solid content of steam leaving boiler, thus protecting superheater and turbine blading. Placed inside boiler drum. Water from feed box spreads over initial screen and forms curtain through which steam must pass on way to outlet. This washes steam with clean feedwater and removes much of solid content. Subsequent screens take out entrained water, thus reducing water content to original level. Also reduction in film tension probably reduces tendency to carry over suspended water particles. Heavy wire screen made up in panels which can be passed through drumhead manholes. All except overhead screens ahead of steam outlet are assembled in place without bolts or tools. Where all steam from boiler tubes and water walls enters on one side of drum, a single washer arrangement is used (illustrated); where entrance is from both sides, duplex arrangement is necessary. This is just second set of screens on opposite side. Even in 400-lb. boilers, this unit reduces solid carryover to 1 per cent of that in incoming boiler feed.

Combustion Engrg. Co., Inc., 200 Madison Ave., New York.

Hydro-Electric Plant

This complete self-contained unit now available for a.c. output as well as d.c. and with complete ball-bearing mounting



of revolving parts. Proper combination of turbine, governor and generator. Includes vertical, direct connection between turbine and generator, built-in governor and necessary valves, instruments, framework, and housing. Automatic unit suitable for 24-hr. per day service. Standard capacities ½ to 5 kw., voltages 32, 125 to 250. Larger units or special designs by order.

Hoppes Water Wheel Co., Springfield, Ohio.

Portable Instruments

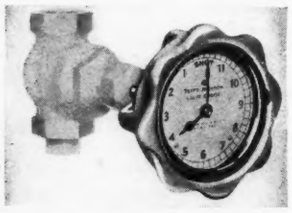
Types NPD and NPA (first d.c., second a.c.) instruments are for standard testing purposes. Rugged, reliable, low in cost. NPD line includes ammeters, voltmeters, milli-volt-

meters and milli-ammeters of all ranges. NPA same sizes and style of case. Accurate to one-third of 1% of full-scale value. Voltmeters to 750 volts, ammeters to 75 amp. (larger sizes with shunts). Single or double range.

Roller-Smith Co., 233 Broadway, New York, N. Y.

Valve-Position Indicator

This unit, replacing valve wheel, tells at a glance whether valve is open or shut, or what porportion open. Standard in-



dicator wheel diameter 4¾ in., special sizes to order. Suitable for all types of wheel valve control and avoids guesswork and uncertainty.

Tefft-Jackson, Inc., 120 Main St., Pawtucket, R. I.

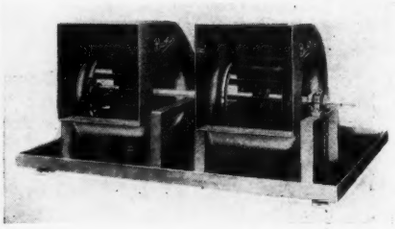
Fire-Resisting Cable

Pyranol-treated paper-insulated cable now available for 600 volts and low-voltage network cables. Higher voltages later. Pyranol volatilizes at arc temperatures, but produces no inflammable gases and acts as fire extinguisher on paper insulation, thus avoiding former troubles when cables failed.

General Electric Co., Schenectady, N. Y.

Fan Mounting

"Drip-Pan" mounting for Type HVA fans is heavy sheet metal, welded at all seams and leakproof. Pan large enough to catch dripping condensation, and drain connection provided. To combine heating and cooling coils and filters with fan. Clips provided for attaching casing

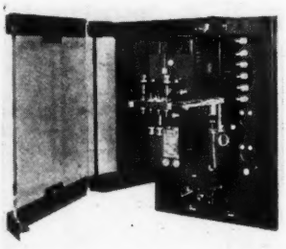


around coil or filter and enclosing fan inlet. Casing sheet metal or insulating board. For quiet operation, entire unit can be mounted on rubber. Eight sizes, shipment from stock.

Buffalo Forge Co., Buffalo, N. Y.

Generator Voltage Regulator

For use either as exciter or generator rheostatic regulator, this PR regulator accommodates two sets of contacts, one used to operate motor-operated rheostat under minor voltage fluctuation, other functioning under major voltage fluctuations to actuate contactors which short-circuit rheostat resistance. Can be used for either alternating-current or direct-current equipment without modifying element. When



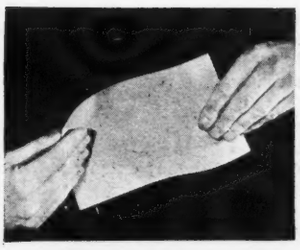
used on a.c. systems of standard 3-phase type, regulator functions to maintain an average voltage on three phases.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Thermostatic Steam Trap

TAG thermostatic steam trap is now in three sizes, ½, ¾ and 1 in. with greater capacity and steam economy. Adjusting screw at top may be set to discharge condensate at temperature corresponding to as much as 20 lb. less than operating steam pressure, whether it is 50, 75 or 125 lb., without further adjustment. Renewable and reversible Monel seat, renewable stainless steel ball valve, renewable valve guide. Bulletin 1084.

C. J. Tagliabue Mfg. Co., Park and Nostrand Aves, Brooklyn, N. Y.



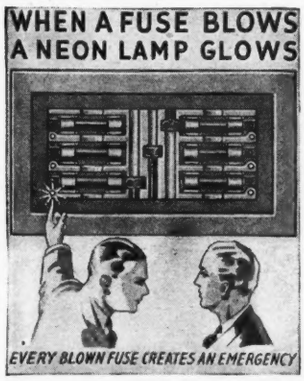
Separators for Storage Batteries

Exide-Ironclad Batteries now have separators of Exide Mipor (Reg. U. S. Pat. Off.) a form of vulcanized rubber in sheets, permeated with countless microscopic passages permitting free diffusion of electrolyte. So small are these passages that most minute solid particles of active material are prevented from passing through. These separators are not affected by electrolyte. Because they are vulcanized with heat during manufacture, they are immune to heat developed in a battery. They have mechanical strength necessary to withstand vibration. Tests in laboratory and field have shown that Mipor lasts indefinitely, functioning as a permanent electrical insulator, yet always permitting complete diffusion of electrolyte.

Electric Storage Battery Co., Allegheny Ave. & 19th St., Philadelphia, Pa.

Indicator For Fuses

Porcelain plug and cartridge cutouts with neon lamp indicators. When a fuse blows, neon lamp glows, quickly identifying

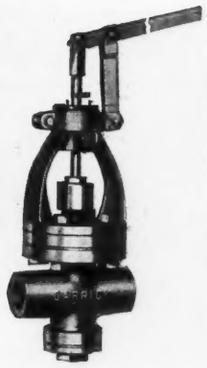


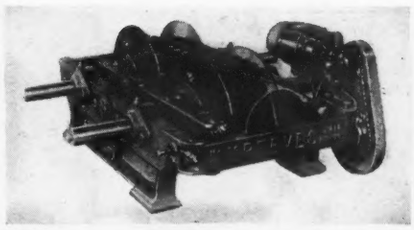
blown fuse. Inserting new fuse puts out light. Not affected by short circuits or current surges.

L. S. Brach Mfg., 80 Duryea St., Newark, N. J.

Flow-Control Valve

Carrick Type FT #1 adjustable Flo-Trol valve is moving-plug type. Valve body and all external parts except lever are cast hard bronze for usual





steam conditions. For high steam conditions, body and head flange cast steel. Other external parts gray cast iron. Operating lever always Monel and stem stainless steel. Screwed connections standard, but flange connections available. Steam passing through does not contact seats, thus avoiding wire-drawing. Unit usually controlled by automatic device and is part of combustion control system. Can be used to control flow of other fluids also.

Carrick Engrg. Co., P.O. Box 299, Michigan, City, Ind.

Electrical Operation Recorder

This instrument, instead of making one circular record, draws a spiral curve starting at outer edge of chart and moving toward center. Telechron cam continuously resets record-making movement to get this result. One model has chart-driving clock making 1 r.p.hr. and separate Telechron motor-driven cam making 1 revolution in 8 hr. Resulting record is spiral curve covering 8 rotations of chart and with about $\frac{1}{4}$ in. spacing of record line. Recording mechanism is small electro-magnet energized when external circuit is closed. Magnet movement actuates pen arm and moves inking pen about $\frac{1}{16}$ in. Entire movement in moisture-proof rectangular Model 40m case.

Bristol Co., Waterbury, Conn.

Graphite Lubrication

"Graph-Air Gun" was designed for applying "Microfyne" flake graphite, a lustrous silky lubricating powder. Gun is made of rubber, and when squeezed deposits graphite where needed in measured amounts through positively controlled air pressure. Graphite volume is largely controlled by position of nozzle in relation to dial on top of gun. Nozzle may be turned to shut-off position, making gun practical to carry in tool kits. Plug fitted to bottom of gun, easily snapped in and out, carries a disk of chamois for use as a burnisher. Standard nozzle is 2 in., but 8-in. nozzle may be secured at small extra cost. Microfyne graphite may be used as a lubricant for wood, rubber, leather, paper, fiber, composition, varnish, lacquered or painted surfaces.

Joseph Dixon Crucible Co., Jersey City, N. J.

Electric Variable-Speed Control

Improved electric remote and electric automatic controls for Reeves variable-speed transmission. Smaller, more compact motor used on speed-shifting screw. Need not be mounted on transmission proper and embodies built-in speed reducer providing any ratio up to 1,000:1 and safety clutch to avoid overload, thus eliminating former solenoid brake. Output shaft of motor-reducer runs at 150 r.p.m., driving transmission shifting screw through pitch roller chain of 3:1 ratio. Two motors available, 100-125 or 200-250 volts, as required. Rated $\frac{1}{16}$ hp. Automatic control booklet T-5645; electric remote control booklet T-5640-A.

Reeves Pulley Co., Columbus, Ind.

Improved Blowpipe

New type ball-seat needle valve now being used on Oxweld blowpipes, interchangeable with older types. Consists of seat between blowpipe body and needle valve consisting of hardened stainless steel ball in cage at end of valve stem. Easier control, less maintenance.

Linde Air Products Co., 30 E. 42nd St., New York, N. Y.

General-Purpose Electrode

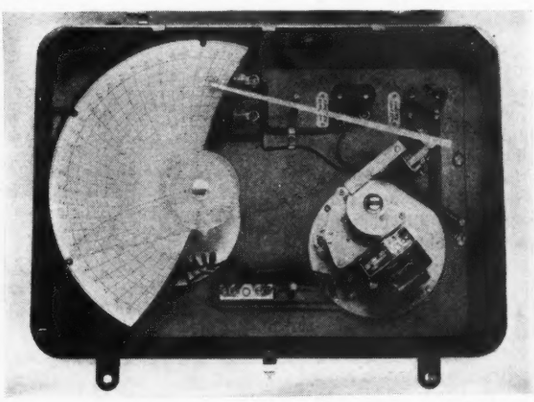
"Fleetweld" No. 7 is heavily coated shielded-arc electrode for general use on mild steel. High-speed, single-pass use, particularly where fit-up is poor. Tensile strength 70,000 to 80,000 lb. per sq.in. 14-in. lengths, in 50-lb. packages, all common diameters.

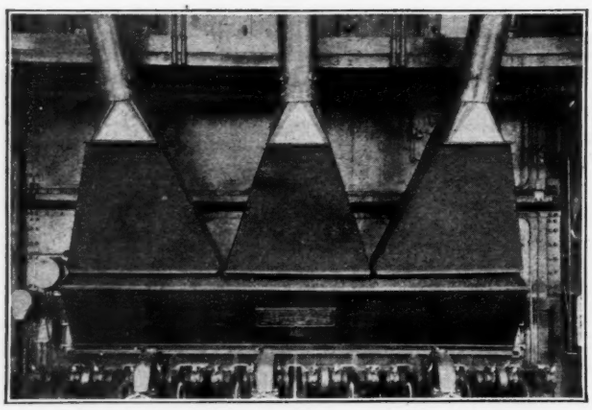
Lincoln Electric Co., Coit Rd. and Kirby Ave., Cleveland, Ohio.

Enclosed Fan-Cooled Motors

Totally enclosed and fan cooled, these d.c. motors are available in sizes of $\frac{1}{2}$ to 200 hp. Dual ventilation system used, with watertight conduit boxes and labyrinth seals at cartridge-type bearing housings. Internal fan circulates inner air to shell to permit heat transfer, while external fan draws air across shell to cool it.

General Electric Co., Schenectady, N. Y.

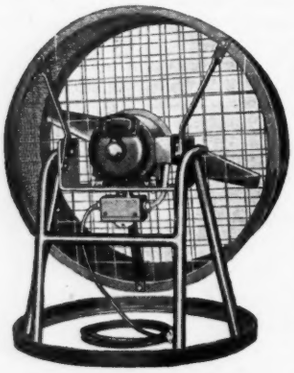




Coal Distributor

Non-segregating coal distributor for stoker hopper feeding. Insures even distribution of coarse and fine portions over fuel bed, bettering efficiencies and cutting maintenance. Fixed internal deflecting vanes in two series diverge and run about parallel to side of chute. As soon as the chute is filled these form supply channels for multiple small feed streams covering entire inner part of chute, flowing under confinement to stoker hopper.

Fairfield Engrg. Co., 322 Barnhart St., Marion, Ohio.



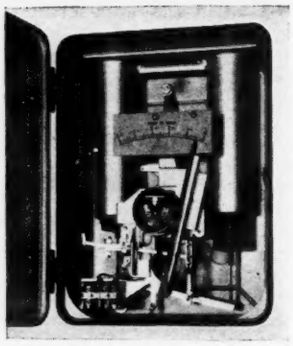
Ventilating Fans

Series of fans, including wall, ceiling, floor and duct-mounted types. "Aerospot" floor-level unit supplies blast for 60 ft (E-1 model) or 90 ft. (E-2 model), with widths 45 and 60 ft. respectively. Blast direction adjustable from horizontal to vertical. Blades drop-forged aluminum alloy, intake rings and supports rolled steel. Motor totally enclosed. Small power requirements.

Bendix Products Corp., South Bend, Ind.

Control Trip

Guards against explosive mixtures of fuel and air when lighting off pulverized coal, gas or oil-fired boilers. Withholds fuel feed until boiler is thoroughly purged. Essentially two

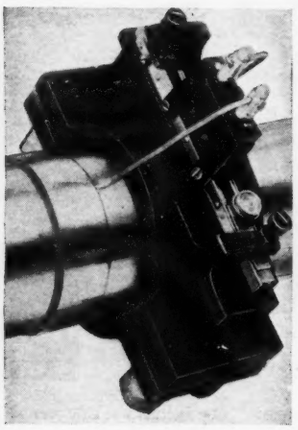


oil-sealed bells suspended from beam to measure air flow through boiler. Draft connection from right-hand bell to boiler furnace, and from left-hand bell to last pass gives draft loss for measurement. Whole mechanism, including snap-acting contactor and indicating pointer, enclosed. Primary function is operating snap-acting contactor (in circular casing between bells). Contactor connected to air flow mechanism by linkage so that air flow must reach 60 per cent of capacity before contactor closes and permits operation of fuel feeder motor relay or control valve. Contactor stays closed until air flow approaches zero, thus permitting operation through entire control range without tripping out fuel feed.

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.

Torsion Meter

Maihak type torsion meter measures power transmitted by a shaft, operating on principle that musical tone produced by vibrating cord depends upon rate of vibration, which in turn is proportional to square root of tension. Torsion element illustrated is fastened on shaft and revolves with it. Consists of two split sleeves rigidly clamped 15 in. apart. Each sleeve has projecting arm, and between these arms, tangentially to shaft, stretches a hard alloy steel cord 5 in. long. Directly above cord is small electro-magnet, setting cord in vibration when circuit is made or broken. This produces a.c. in magnet coils of frequency same as rate of vibration of cord. Cord vibration rate depends on tension, which in turn depends on torsional deflection of shaft. Current led in and out by slip rings and brushes carrying leads for receiving set at any convenient distance. In receiving set is comparison cord stretched by micrometer screw and carrying magnifying glass and large scale to show strain thus induced. Pitch of tone of wire on revolving shaft can thus be duplicated on cord in receiving set, and torsion attained by comparison.



Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa.

Silchrome Exhaust Valve

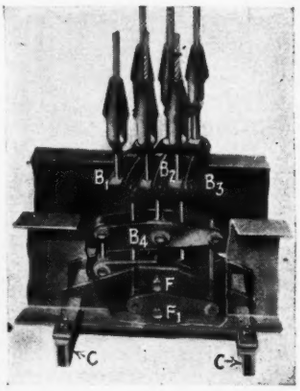
Four or five times usual life is claimed for this silicon-molybdenum seated "Sili-seat" exhaust valve for internal combustion engines. Body is molybdenum steel forging.

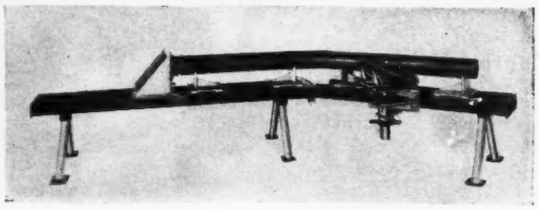
Meriam Co., 1955 West 112th St., Cleveland, Ohio.

Pipe-welding Fixture

Capable of handling all sizes of pipe to 12 in., this fixture will line up accurately and hold in position for tacking fittings, flanges, and branches at any angle. Extension bench for longer lengths. Adjustable elevator, usable on main fixture or extension, controls vertical alignment. Elevator supports graduated for accurate angle setting. Main bench and extension are I-beams on tubular legs. Elevating and V supports steel. Main bench weighs 700 lb., extension 300. Easily assembled and disassembled. Main bench I-beam 8 ft. long, 2 ft. high, 1 ft. wide; extension 6 ft. long.

Oster-Williams, 2057 East 61st Place, Cleveland, Ohio.



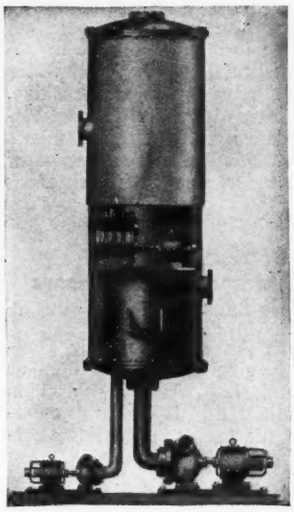


Roller Bearing Elevator-Rope Equalizer

Automatic equalizers are essential in traction-elevator hoisting-rope installations, if loading on ropes is to be equally divided and their life prolonged. Low friction is essential in an equalizer if efficient equalizing is to be obtained. This new equalizer, consequently, is equipped with specially designed roller bearings.

In six-cable design shown, ropes connect to ends of three equalizing bars B_1, B_2, and B_3. Bar B_2 connects to center of equalizing bar B_4. Ends of this bar connect to one end each of two other equalizing bars fulcrumed at F and F_1. Bar B_1 connects to one end of bar fulcrumed at F_1 and B_3 to bar fulcrumed at F. Equalizing equipment is attached to plates by fulcrum shafts F and F_1, and these plates support car by two bars C that pass through them under car's crosshead. Ropes are thus free to equalize load between them. Since each of 18 fulcrum and connection pins is equipped with a roller bearing specially designed to have low friction, a small differential in rope loading causes equalizer to function and distribute load equally on ropes.

L'Code Corp., subsidiary A. B. See Elevator Co., 419 4th Ave., New York, N. Y.



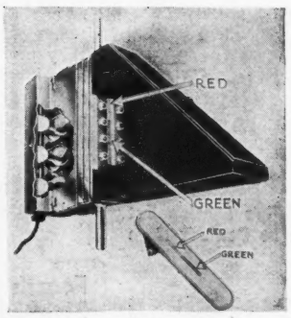
Steam-Operated Cooler

Produces cooled water by means of flash or instantaneous evaporation under vacuum. Thus economical source of drinking water, cooled water for air coolers or conditioners, or other use where water is needed at 40 to 50 deg. F. Steam cooler fully contained within single tank 2 ft. in diameter and about 6 ft. high. Within tank is low-pressure evaporating compartment, steam-jet compressor and condenser. Outside tank is pump for circulating cooled water and pump for removing condensing water. Auxiliary motor-driven vacuum pump on side to maintain reduced pressure in condensing compartment. Entire plant takes space 3 ft. square by 8 ft. high. Water only refrigerant; top half of unit insulated. Low-pressure steam enters at top, water to be cooled at upper left into low-pressure compartment under pressure of 0.3 in. Hg. Water adjusts itself to corresponding temperature of 45 deg.—boiling point at that pressure—by evaporation under vacuum created by steam jet. Usual steam-jet process. Condensing water from any source enters at lower right and is removed by pump. Unit shown 15 ton, two others smaller. Larger units in less compact arrangements.

Elliott Co., Pittsburgh, Pa.

Two-Color Water Gage

"Diamond" bi-color water gage and illuminator avoids boiler water level reading difficulties and mistakes. Replaces existing gage on boilers and shows water green and steam red by means of light behind column. Utilizes difference in indices of refraction of water and steam. Electric lights project red and green bands of light side by side on water column. Part of column

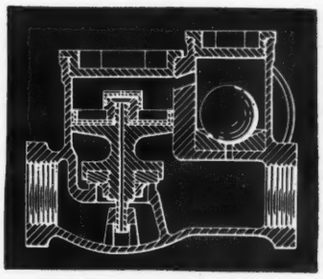


filled with water deflects red beam so that it does not emerge and observer sees green beam only; part of column filled with steam deflects green beam similarly. Standard single gage has 12-in. sight, double gage provides 21½-in. sight. Can be used for direct reading or for reflected reading at firing floor, as illustrated.

Diamond Power Specialty Corp., Detroit, Mich.

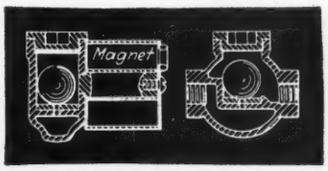
Electro-Hydraulic and Electro-Magnetic Valves

Hoppe electro-hydraulic valve uses 16 watts per hr. Body steel, bronze or non-magnetic iron for ammonia, air, CO_2, F-12, steam and water. Can be used wherever



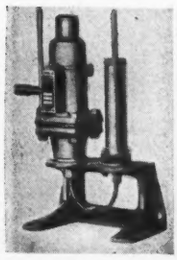
stop valve is needed or as pressure-reducing valve for steam. Pressures to 250 lb., sizes ¼ to 1 in. Line pressure opens and closes unit; automatically closes when current is off.

Also electro-magnetic unit similarly used, although only ¼-in. size is now available. For remote control of fluid lines. Bronze or non-magnetic body with housing at-



tached for solenoid or magnet. When magnet is energized, it rolls ball horizontally from seat, holding it against wall as long as current is on. Balls usually stainless steel.

Myers Engineering Equipment Co., Mart Bldg., 501 S. 12th St., St. Louis, Mo.



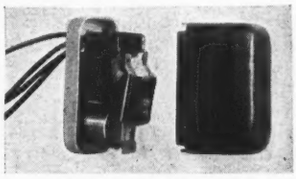
Electric Flow Meter Body

For measuring flow of any liquid, vapor or gas creating differential pressure across an orifice of 1.6 to 16 in. mercury. Easy to clean, rugged, simple, easy to change range. Seamless steel U-tube with union compression fittings connects high- and low-pressure chambers. Mercury drain on tube has hardened needle-point screw to seal it. Two oil-resistant, resilient seals seat in high-pressure chamber, one above float, one below. As mercury level rises and falls with flow changes, high-pressure float follows, its motion being transmitted electrically to indicating or recording meter by inductance bridge. No welding or welded parts; forged steel pressure chambers. Working pressures to 2,500 lb. per sq. in. Base interchangeable for wall or floor mounting.

Brown Instrument Co., Philadelphia, Pa.

Solenoid Control Relay

Type Hg-15 is for use in copper-oxide rectifiers. Coil operates on d.c. side or rectifier

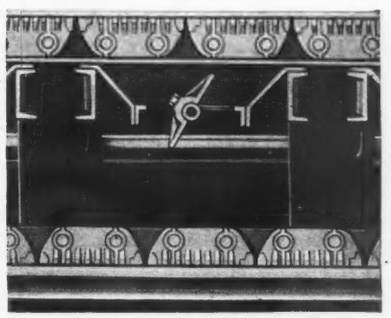


and contacts on a.c. side. Will successfully make and break currents up to 50 amp. at 220 volts. Weighs 2¼ lb.

General Electric Co., Schenectady, N. Y.

Natural-Draft Chain-Grate Stoker

"Green" stoker modified for fixed attachment of controls, greater ability to cope with expansion and simple conversion to forced draft if desired. KS design has stationary frame fixed into setting of transverse channels supported by side posts. Posts held to side walls by angles parallel with walls; skids on I-beams carry chain weight at bottom. Adjusting



rod carried in pipe which takes tension off frame. Takeup at rear, with adjustment from front. Zone control with natural draft if desired by placing louvres between channels, as shown. Forced draft links, dampers and internal hood and seal at front convert unit for forced draft. Water-cooled rear shaft optional.

Combustion Engrg. Co., Inc., 200 Madison Ave., New York, N. Y.

High-Tensile Electrode

"Shield-Arc 85" gives welds with 85,000 to 100,000 lb. per sq. in. tensile strengths on high-tensile steels. Ductility 15 to 25% in 2 in. Heavily coated for low-alloy structural steels in this tensile range when normalized. In 5/32- and 3/16-in. sizes.

Lincoln Electric Co., Coit Rd. & Kirby Ave., Cleveland, Ohio.

Flexible Coupling

Type WH consists of two identical cast-steel flanged halves, two sheet-steel cover plates, two snap rings, and from 5 to 22 flexible elements, depending on size. Flexible elements fit into slots in peripheries of halves to cushion operation. They are of hydraulic packing; torque is

transmitted by rectangular steel plate. Torque elements go in center slot with cushioning element at each side. Snap ring through grooves in flexible elements and flange periphery prevents lateral or radial movement of elements. Cushioning elements avoid lubrication and can be replaced without disturbing flanges. Safe to use at speeds up to 8,000 f.p.m.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Wide World

90-Ton Pipe Section Set in Place at Boulder Dam

One section of the largest steel pipe ever fabricated for an engineering project is here being placed in final position in the upper Nevada intake tower of the Boulder Canyon project, on July 24, marking another step in the construction of the great Boulder Dam. The pipe is 30 ft. in diameter, 21 ft. long and weighs 90 tons

POWER LINES

Minneapolis To Be Host for 52nd N.A.P.E. Meeting

The 52nd annual convention and power show of the National Association of Power Engineers is to be held in Minneapolis, Minn., this year, from Aug. 27 to Sept. 1. Exhibits will be housed in the Municipal Auditorium and will represent about 200 manufacturers. Five convention sessions will be held, as well as the usual social meetings and evening programs. Several inspection trips are also planned, as well as the 27th meeting of the Minnesota State Association, Aug. 27, in the Curtis Hotel. Prof. Elliott, of the University of Wisconsin, will deliver a lecture to the group on Thursday, Aug. 30. A number of events are also scheduled for the Ladies Auxiliary.

Power Show Advisors Announced

The advisory committee composed of distinguished engineers and industrialists of the Eleventh National Power Exposition, which occurs Dec. 3 to 8, at Grand Central Palace, New York, has been announced. The Exposition Advisory Committee in connection with the National Power Show has proved of great value in previous Expositions. Chairman of this year's Committee will be Irving E. Moultrop. The other members of the Committee are: Homer Addams, past president, American Society of Heating & Ventilating Engineers; N. A. Carle, manager, Puget Sound Bridge & Dredging Co.; Paul Doty, president, The American Society of Mechanical Engineers; Fred Felderman, past-national president, National Association of Power Engineers; Charles V. Haynes, president, American Society of Heating & Ventilating Engineers; C. F. Hirshfeld, chief, Research Department Detroit Edison Co.; O. P. Hood, chief mechanical engineer, U. S. Bureau of Mines; John H. Lawrence, Thomas E. Murray Co.; Fred R. Low, past president, The American Society of Mechanical Engineers; David Moffatt Myers, consulting engineer; Fred W. Payne and Charles F. Roth, co-managers of Exposition.

At the last report, space had been taken by about 150 companies for this year's show.

New Diesel Fuel Classification Planned

At the A.S.T.M. annual meeting in Atlantic City, Committee D-2 announced that a classification of diesel fuel oils will soon be published for information and criticism. It divides diesel fuel into five grades with suggested minimum limiting characteristics necessary to insure economical satisfactory engine performance. Oils are classified with respect to flash point, water and sediment, viscosity, carbon residue, ash, pour point and ignition characteristics in accordance with the requirements of engines classified as to speed, type of injection, cylinder size and preheating equipment.

Fourth Conference for Engineers Planned This Month

The Fourth Annual Economic Conference for Engineers is to be held at Stevens Camp, N. J., Aug. 11-19. This conference, initiated in 1931, has as sponsors most of the larger engineering colleges of the East. This year's program deals largely with NRA, the general theme being "An Economic Appraisal of the New Deal." The program includes a number of noted speakers, each discussing that phase of the problem with which he is most familiar. Further information is available from the President's Office, Stevens Institute of Technology, Hoboken, N. J.

Survey Shows Results In Chicago Smoke Campaign

According to a recent report by Frank A. Chambers, director of the Chicago City Smoke Department, as much work was accomplished during the first three months of this year as is normally accomplished in a year. This was because the regular city force of 16 was augmented by 168 CWA workers. These latter were stationed throughout the city, surveying boiler plants, observing all chimneys and stacks, and giving instructions in schools to janitors and firemen on proper methods of stoking furnaces. The Federal expenditure on this work was $64,029, but it had the effect, according to Mr. Chambers, of instituting furnace reconstruction and new installations amounting to $413,960. Some 152,528 stacks were observed, as compared with 70,850 for all of last year, and 4,868 violations reported, as compared with 2,171 all last year. 11,149 instruction visits were made, as compared with 11,623 all last year. The survey showed that average dust fall per sq. mi. per mo. is now 107.7 tons, as compared with 230.33 tons in 1932.

Parsons Memorial

The British Royal Society is sponsoring a movement in England to perpetuate the memory of Sir Charles Parsons and his great work on the steam turbine by erecting some sort of suitable memorial there. The Institution of Mechanical Engineers is taking part in the movement, and has suggested that the maximum donation of any member is not to exceed two guineas (about $10). For those American engineers wishing to contribute, further information can be obtained from the Royal Society, Burlington House, London, W.1, England.

Iron & Steel Meeting In Cleveland Next Month

Sponsored by the Association of Iron & Steel Electrical Engineers, a convention and iron and steel exposition will be held in Cleveland, Ohio, Sept. 18-20. Papers of particular interest to power engineers are "Servicing of Steam Turbine, Diesel and Transformer Oils," "New Developments in Lubrication," "Oiling System Installation — Piping and Arrangement," "General Discussion —Lubrication Problems," "Relative Values of Fuels as Applied to the Steel Industry," "The Generation of Power in Industry by Diesel Engines Using Heavy Fuel Oils," "Increasing the Output of Steam Power Plants by Superimposing High-pressure Turbines and Boilers," "Industrial Uses of Propane and Other Liquefied Petroleum Gases."

Flywheel Explosion Kills Man

July 2, the flywheel on the main engine driving all machinery in the plant of Basic Furniture Co., Staunton, Va., exploded due to overspeed, killing C. H. Harris, 60, engineer. The wheel, about 16 ft. in diameter, failed, one piece striking Harris on the head. The cause of overspeed was not definitely established, although it apparently was not loss of load because the driving belt, 2 ft. wide, was torn to pieces by the explosion. Apparently Mr. Harris had attempted to slow down the engine, for the throttle valve was partly closed.

Increase in Show Activity Seen By Exhibitors

A listing of the more important industrial and trade shows, issued recently in a Bulletin of the Exhibitors Advisory Council, showed that more shows and expositions have been held during the first six months of 1934 than were scheduled over a similar period in 1933. In addition, the Council, through its trade association and show management contacts, has learned that show promoters and trade groups sponsoring shows are anticipating a larger number of exhibitors and more responsive attendance at their shows scheduled this Fall and next Spring.

Since 1926, the Exhibitors Advisory Council has been issuing data on all phases of show and exposition work and has been instrumental in the improvement of conditions relating to shows.

2,000-Ton Air Conditioner To Go in Deep Gold Mine

A record air-conditioning project requiring more refrigeration than any other similar installation has just been announced for the Robinson Deep Mine in the South African gold fields. This mine is one of the deepest mines in the world, its workings penetrating 8,000 ft., or nearly a mile and a half, below the earth's surface. At the bottom of this gold mine temperatures of more than 100 deg. are encountered, with extremely high humidity sometimes approaching saturation. These unbearable working conditions have made it impossible to open lower levels and have greatly decreased the efficiency of working those now already reached.

Air conditioning for this mine has been designed to supply 400,000 cu.ft. of air per min., the cooling of which will require 2,000 tons of refrigeration. The project involves a total expenditure of approximately $500,000. Condensing water for the refrigerating plant will be required at the rate of 7,500 g.p.m. from a cooling water spray pond as large as a football field. The refrigerating equipment consists of three Carrier centrifugal machines employing Carrene and requiring 750 hp. each.

Air will be cooled in a single dehumidifier or spray chamber 50 ft. long by 16 ft. high, which will use 8,400 gal. of spray per min. Under extreme conditions it is expected that more than 1,300 gal. of water per hour will be extracted from the air.

The conditioned air is to be handled by two fans which will discharge into the mine shaft through an underground tunnel, entering the mine about 100 ft. below the surface. Approximately 23,600 lb. of air per minute will be handled by these fans.

COMING MEETINGS

Economic Conference of Engineers—Fourth annual meeting, Stevens Institute of Technology Engineering Camp, Johnsonburg, N. J., Aug. 11-19. Harvey N. Davis, Stevens Institute of Technology, Hoboken, N. J.

International Association of Municipal Electricians — Wardman Park Hotel, Washington, D. C., Aug. 29-Sept. 1. W. H. Harth, City Hall, Columbia, S. C.

Producers and Distributors of Electrical Energy—Fifth International Congress, Zurich and Lausanne, Switzerland, Aug. 29-Sept. 7. Secretary, Union des Centrales Suisses d'Electricite, 301 Seefeldstrasse, Zurich.

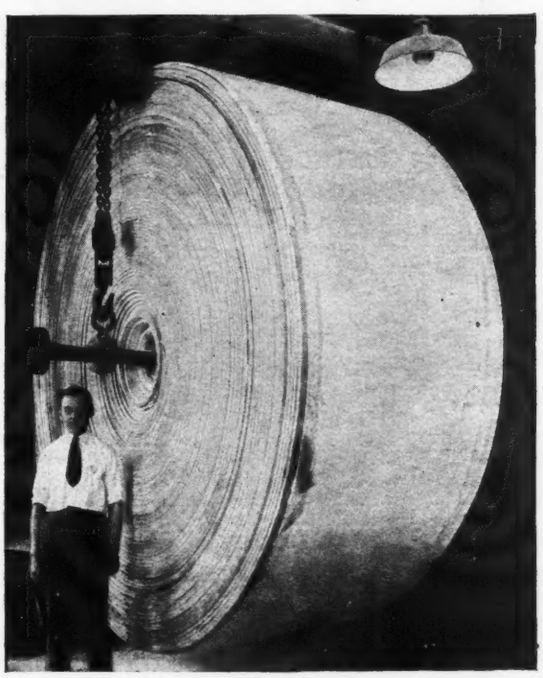
American Institute of Electrical Engineers—Pacific Coast Convention, Salt Lake City, Utah, Sept. 3-7. General Convention Committee, 1016 Continental Bank Bldg., Salt Lake City, Utah.

Association of Iron and Steel Electrical Engineers—30th convention, held in conjunction with the Iron and Steel Exposition, Cleveland, Ohio, Sept. 18-20. J. F. Kelly, Empire Bldg., Pittsburgh, Pa.

Electrochemical Society — Sixty - sixth convention, Hotel Pennsylvania, New York City, Sept. 27-29. Colin G. Fink, Columbia University, New York.

National Association of Power Engineers—52nd Annual Convention and Power Show, Municipal Auditorium, Minneapolis, Minn., Aug. 27-Sept. 1. Fred W. Raven, secretary, 1140 Lake St., Oak Park, Ill.

American Society of Mechanical Engineers — Annual Meeting, Engineering Societies Bldg., New York, N. Y., Dec. 3-8. Calvin W. Rice, secretary, 29 W. 39th St., New York, N. Y. Also 11th National Power Show, same dates, Grand Central Palace, New York, N. Y. Chas. F. Roth, manager.



FOUR FEET BY A QUARTER MILE

This single-piece rubber belt is 1,291 ft. long and 4 ft. wide, of 7x9-ply heavy duck construction with a ¼-in. reinforcement on top and 1/16-in. reinforcement on back. Weighing 11 tons, it will deliver 1,500 tons of crushed limestone an hour in a limestone plant. Built by Manhattan Rubber Mfg. Division of Raybestos-Manhattan, it required 16 bales of raw cotton.

British Stations to Spend $25,000,000 on New Plants

Extensions and improvements estimated to cost approximately $25,000,000 will be undertaken immediately by British central station owners under plans approved by the British Electricity Commission. Projects sanctioned include the installation of additional generating sets and boiler plants at a number of stations, including Sheffield, Blackburn, Hull, Southampton, Leeds, Bristol, Newport, Norwich and Liverpool. Chief among the projected expansions will be the enlargement of the Neepsend generating station at Sheffield at an estimated cost of $2,195,000 and the Blackburn Meadows No. 2 station at a cost of $2,110,000.

Power Transmission Code Passed

The supplemental code of the power transmission industry has been passed by General Johnson. Wage provisions are similar to those of the code for the machinery and allied products industry.

Bay State Smoke Inspection Department Re-Established

Gov. Ely of Massachusetts has signed a bill re-establishing the department of smoke inspection for the Boston metropolitan area, following about a year of divisional operation on a greatly reduced basis. The smoke prevention service was formerly a separate department under the direction of the Department of Public Utilities, and attained a vigorous development embodying the examination of designs of new and improved heating plants as well as supervision of operating installations from the smoke viewpoint. At the time of its curtailment it had about 19 employees, its total cost being about $55,000 per year. Recently the Legislature cut out the departmental status of the work and cut down the force about 50 per cent. It remained under the Utilities commission, and will continue under that supervision in the new status. There is not much likelihood of any marked increase in staff at present, but under the restored departmental status the work of the organization can be expanded if the commission so determines, and a more complete inspection maintained. Inspection of plant designs was cut out of the bill before passage. W. A. Edson is at present in charge.

Pipe Standards Announced By Standards Association

The American Standards Association, after seven years of work, has announced approval of nine standards for wrought-iron and steel pipe, two being approved as standards and seven as tentative standards. An analysis of the individual standards is presented below. Standards cover outside diameters, wall thicknesses, tolerances, and materials for several schedules of 1,000 P/S values, ranging from 10 to 160.

Standard Specifications for Welded and Seamless Steel Pipe (B36.1-1934) cover standard weight, extra-strong, and double-extra-strong pipe, suitable for coiling, bending, flanging, etc. The Code for Pressure Piping allows the use of pipe as specified by this standard in power piping systems for pressures not in excess of 250 lb. per sq.in. at 500 deg. F.; as well as in gas and air piping systems, district heating systems, and for oil piping.

Standard Specifications for Welded Wrought-Iron Pipe (B36.2-1934) cover standard weight, extra-strong, and double-extra-strong pipe suitable for coiling, bending, flanging, etc. The Code for Pressure Piping allows the use of this pipe in power piping systems from 250 lb. per sq.in. to 400 lb. per sq.in.; as well as in gas and air piping systems, district steam heating, and for oil piping.

Tentative Specifications for Lap-Welded and Seamless Steel Pipe for High-Temperature Service (B36.3-1934) are for pipe for 250, 300, 400, 600, 900, and 1500 lb. per sq.in. at high temperatures, suitable for bending, flanging, and similar services. Supplementary requirements of an optional nature are provided for seamless pipe intended for use in central stations having steam service pressures of 400 lb. per sq.in. or over and temperatures up to 750 deg. F. or for other applications where a superior grade of pipe is required. The Code allows use of this pipe in power piping systems with pressures above 250 lb. per sq.in., in oil piping systems, and district heating systems.

Tentative Specifications for Electric-Fusion-Welded Steel Pipe (Sizes 30 In. and Over) (B36.4-1934) are for pipe with wall thicknesses up to $\frac{3}{4}$ in.

Tentative Specifications for Electric-Resistance-Welded Steel Pipe (B36.5-1934) cover two grades of pipe up to and including 30 in. diameter for conveying liquids, gas, or vapors at temperatures below 450 deg. F. and is adapted for flanging and bending in smaller sizes. The Code allows the use of this pipe in power piping systems of from 250 to 400 lb. per sq.in., and in gas and air piping systems, and district heating systems.

Tentative Specifications for Forge-Welded Steel Pipe (B36.6-1934) covers two grades of pipe in sizes from 14 in. to and including 96 in. in diameter, and wall thicknesses from $\frac{1}{4}$ in. to $1\frac{1}{4}$ in. inclusive. The pipe is intended for various uses. The Code allows its use in power piping systems, gas and air piping systems, and district heating systems.

Tentative Specifications for Lock-Bar Steel Pipe (B36.7-1934) is for pipe suitable for liquids or gases. This pipe is made from steel plates rolled or formed into a circle, having longitudinal edges planed and upset to a dovetail form which engages in the grooves of an H-shape steel lock bar to form the longitudinal joint of the pipe. The Code allows its use in gas and air piping systems.

Tentative Specifications for Riveted Steel and Wrought-Iron Pipe (B36.8-1934) covers shop-fabricated straight pipe, suitable for conveying liquids or gases. It is made from steel or wrought-iron plates with riveted seams. The Code allows its use in power-piping systems, gas and air piping systems, and district heating systems.

Tentative Specifications for Electric-Fusion-Welded Steel Pipe (Sizes 8 In. to but not Including 30 In.) (B36.9-1934) are for two grades of pipe in sizes from 8 in. to but not including 30 in. in diameter, and with wall thicknesses up to $\frac{5}{8}$ in. inclusive. This pipe is intended for conveying liquid, gas, or vapor at temperatures below 450 deg. F. and is adapted for flanging and bending. The Code allows its use in power piping systems from 250 to 400 lb. per sq.in., and in gas and air piping systems.

B.C. Boiler Legislation

The insurance companies of Canada presented a petition to the B.C. Government in February of this year (*Power*, May, page 262), requesting that the Boiler Inspection Act be amended, so that the companies carrying boiler insurance would be exempt from Government inspection. This request was definitely refused by the B. C. Government.

BUSINESS NOTES

Greenwood Engrg. Co., 935 Allen Bldg., Dallas, Texas, has been organized to succeed J. P. Greenwood, following Mr. Greenwood's death. Gordon Greenwood is heading the organization.

S K F Industries, Inc., after having its executive offices in New York for twenty years, has recently moved them to Philadelphia.

Ernst Water Column & Gage Co., Newark, N. J., has appointed Fenno-Fischer Co., 935 S. 53rd St., Philadelphia, Pa., as representative there.

Maintenance Engrg. Corp., Houston, Tex., has appointed B. I. Thorngren sales engineer engaged in water-conditioning work.

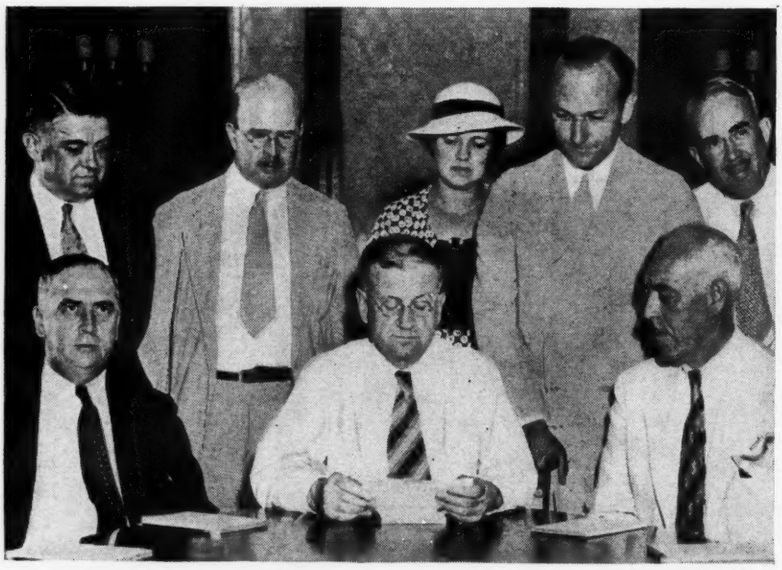
Allis-Chalmers Mfg. Co., Milwaukee, Wis., has moved its Chicago district office to the new Field Bldg., 135 S. La-Salle St.

Glencoy Specialties Co., Zanesville, Ohio, has been appointed special representative of Ironton Firebrick Co., Ironton, Ohio, to cover eastern Ohio, western Pennsylvania and part of West Virginia.

Drake, McGee & Hallsted, Inc., has been formed to market products of 48 Insulations, Inc., 5 Beekman St., New York, N. Y., in the eastern territory.

Chain Belt Co., Milwaukee, Wis., has moved its Detroit warehouse to 5169 Martin Ave. The company has also reopened its Houston, Texas, office under J. W. Snavely at 3118 Harrisburg Blvd.

Isometer Co., Elgin, Ill., has been reorganized under the name Isometer Corp. E. F. Eckel is president, V. W. Eckel secretary, F. Ralph Fisher treasurer. Factory and offices are at 397-399 Silver St.



Wide World

NATIONAL POWER POLICY COMMITTEE

To unify a national power policy and make electricity more broadly available at cheaper rates, was the President's announced aim when he named the National Power Policy Committee. Here are 8 of the 10 committeemen (seated, left to right): Basil Manly; Secretary of Interior Harold L. Ickes, chairman; Robert E. Healy. Standing: Edward M. Markham, T. W. Norcross, Mae Schnurr, TVA Director David E. Lilienthal and Morris L. Cooke. Other members are Dr. Elwood Mead and Frank R. McNinch.

PERSONALS

Wm. B. Henderson, secretary of the Code Authority and Washington representatvie of Machinery and Allied Products Institute, is to become executive vice-president of the Refrigerating Machinery Assn., according to an announcement by the head of the Association, W. S. Shipley, president of York (Pa.) Ice Machinery Corp. Mr. Henderson, also secretary of the Durable Goods Committee, assumed his new duties Aug. 1, when the Association's headquarters were moved from Philadelphia to Washington. This association lists among its members practically all of the important companies in the commercial refrigerating business.

George H. Bucher has been elected president of Westinghouse Electric International Co., East Pittsburgh, Pa.

Louis E. Murphy, formerly president of E. F. Houghton & Co., 240 W. Somerset St., Philadelphia, Pa., has been elected to the newly created office of chairman of the board. He is succeeded as president by Maj. Aaron E. Carpenter. Mr. Murphy has been with the company 44 years, as secretary since the time of its incorporation until 1914, when he became vice-president, then president in 1929 following the death of Charles E. Carpenter. Major Carpenter has been with the company 29 years, as treasurer from 1921 to 1929, when he became first vice-president. He represents the third generation of Carpenters to occupy the presidency of Houghton. George W. Pressell is now vice-president and director of sales, A. Everly Carpenter 3rd is secretary, Dr. R. H. Patch treasurer.

Douglas Annin has joined Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

S. H. Taylor, Jr., formerly in charge of the Los Angeles office of Lincoln Electric Co., Cleveland, Ohio, has been appointed Pacific Coast manager, with headquarters in San Francisco.

John C. Hopkins has been appointed district sales manager of the Cleveland office of General Refractories Co., Philadelphia, Pa. He was formerly with the Central Furnace Division of American Steel & Wire Co. His new headquarters are in the Leader Bldg., Cleveland.

E. C. Gainsborg, for several years sales manager of Roller Bearing Co. of America, Trenton, N. J., has been appointed general manager.

H. S. Colby has been appointed general sales manager of Combustion Engrg. Co., Inc., 200 Madison Ave., New York, N. Y. Mr. Colby was formerly president of Air Preheater Co.

E. H. Tenney, chief engineer of power plants, Union Electric Light & Power Co., has been elected president of the Engineers' Club of St. Louis. He has been acting on the board of directors for several years.

A. D. Hunt has been appointed manager of engineering at the South Philadelphia plant, Westinghouse Electric & Mfg. Co., to succeed John M. Lessells, who has resigned to open an office as consulting engineer.

Paul T. Buckler has joined the New York sales office of Riley Stoker Corp., with headquarters at 103 Park Ave.

Thomas A. Marsh, former president of Modern Coal Burner Co., Chicago, Ill., has joined Iron Fireman Mfg. Co., as central division engineer. Mr. Marsh, a well-known figure in this field, has worked with fuels and fuel-burning equipment for the past 30 years, from 1913-1921 as service man to chief engineer of Green Engrg. Co., 1921-1930 as western engineer for Combustion Engrg. Corp., and 1930-1933 as president of Modern Coal Burner Co. He is an honorary member of the N.A.P.E. and president of the Midwest Stoker Assn. of Chicago. His headquarters will be at 660 N. Wabash Ave.

R. B. Mildon has been elected vice-president of Westinghouse Electric & Mfg. Co. in charge of marketing, engineering, manufacturing and service, having to do with products of the South Philadelphia works.

Lawrence S. Hamaker, sales promotion manager of Republic Steel Corp., has been made vice-president and general manager of Berger Mfg. Co., Canton, Ohio, a Republic subsidiary.

I. W. Lewis, formerly president of Riddell Stoker Co., has been placed in charge of Eastern Division sales for Link-Belt stokers. His offices will be at the Philadelphia plant at 2045 W. Hunting Pk. Ave.

Kenneth Williams has been appointed manager of sales for the department of engineering and construction of Byllesby Engrg. & Management Corp., 231 S. LaSalle St., Chicago, Ill.

A. F. King, has been appointed district sales representative of the Boston office of Reading Iron Co., to replace John G. Ross.

R. E. S. Geare, formerly chief engineer of L. H. Gilmer Co., Tacony, Philadelphia, Pa., has been elected vice-president in charge of sales and engineering.

Alphonse F. Brosky has been appointed special engineer attached to the general offices of Jeffrey Mfg. Co., Columbus, Ohio.

C. W. Piper, 2033 Maple Ave., Norwood, Ohio, has been appointed representative of H. O. Swoboda, Inc., 4301 Main St., Pittsburgh, Pa., for southern Ohio and eastern Indiana.

Clyde E. Williams has been appointed director of the Battelle Memorial Institute, Columbus, Ohio, with Dr. H. W. Gillette as chief technical advisor.

L. Morton Morley has been appointed general sales manager of Brown Instrument Co., Philadelphia, Pa. He was formerly district manager of the Philadelphia office and has been with the company for the past fifteen years.

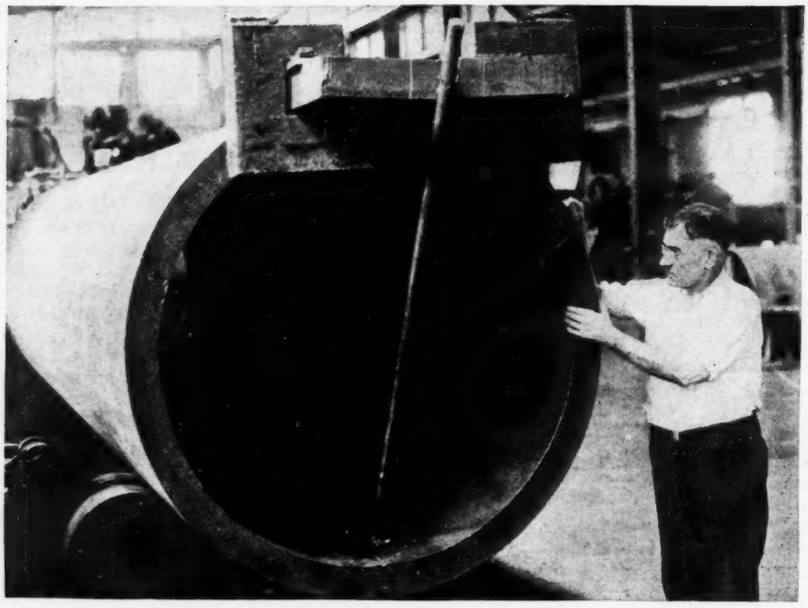
OBITUARIES

John H. Smith, 73, formerly chief engineer of the Eastern Steamship Co. and during the latter part of the world war inspector of engines and boilers at the Brooklyn Navy Yard, died at Watertown, Mass., July 6. He was awarded a silver star for bravery at the time of the Halifax explosion by Secretary of the Navy Daniels, and after the war was connected with the United States Shipping Board fleet. He was widely known in marine steam-engineering circles.

Henry Banning Bradford, 75, for many years vice-president of Edge Moor Iron Co., died July 25 at his summer home, Middle Neck on the Bohemia River, Cecil County, Md., after an illness of several months.

After his graduation from Yale, Mr. Bradford became associated with the Baltimore & Ohio Railroad, with which he was connected from 1881 to 1889. He then became mechanical engineer for Diamond State Engrg. Co., and left that company to become vice-president of Edge Moor, which position he held until his retirement in 1932. Mr. Bradford's more than forty years' active participation in the boiler industry had brought to him associations and friendships throughout the United States. During the years of his association with William F. Sellers, former president of Edge Moor, he gave much to the design of box header boilers and in later years to water-tube boilers.

John E. Barkle, 53, general manager of the South Philadelphia Works, Westinghouse Elec. & Mfg. Co., died suddenly at his home in Swarthmore, Pa., July 10. He had been with Westinghouse for 33 years, as superintendent of the Pittsburgh factory for shells from 1916-1919, service engineer until 1921 when he became general superintendent, then assistant superintendent of the Power Department at East Pittsburgh in 1923. When the coils and insulation departments were added to his department in 1926 he became superintendent of manufacturing of all generating apparatus. In 1929 he became works manager at South Philadelphia and in 1931 general works manager there.



HIGHEST-PRESSURE FUSION-WELDED BOILER DRUM

The main steam drum for the 1,400-lb. boiler being built by Combustion Engrg. at Chattanooga for Firestone Tire & Rubber Co., Akron, Ohio. This drum is 54 in. inside diameter, 23 ft. long and 4 in. thick. It is the highest-pressure large fusion-welded job to date.

STRAWS

Pointing the way business winds blow

Appalachian Electric Power Co. has announced that it will resume work on its 105,000-hp. hydro-electric development on New River, Pulaski County, Va., to cost about $11,000,000. The company has a state license, but the Federal Government claims that the New River, while non-navigable, is a tributary of the Kanawha, and any power development on the New may affect navigation on the Kanawha, and has won court decisions on this basis. Appalachian contends that three-quarters of a million dollars have been spent in acquiring lands. The Government, meanwhile, has surveyed the James and New Rivers, planning a $125,000,000 hydro development.

Marketing of Chrysler Motors new air-conditioning equipment will be undertaken by the Temperature Corporation. Manufactured by Amplex Mfg. Co., a Chrysler subsidiary, the unit is known as the "Airtemp Conditioner."

Indian River Refrigeration Terminal Co., Fort Pierce, Fla., has broken ground for new two-story cold storage and refrigerating plant, 105x360 ft., and will proceed with superstructure at once.

Knoxville, Tenn, has opened and recorded bids for its municipal power and light plant, but contracts are being held in abeyance until it is decided whether or not TVA power will be purchased.

Menominee, Mich., plans new city-owned electric light and power plant. Fund of $803,000 has been secured through Federal aid. T. R. Hasley, city engineer, in charge.

Tecumseh, Mich., plans new city-owned electric light and power plant. Fund of $166,000 is being secured through Federal aid.

Arthur E. Morgan, chairman of TVA, has announced that surveys are under way to determine the most feasible sites for additional dams on the Tennessee River and tributaries, under direction of Carl A. Bock, assistant chief engineer.

Bartlett, Texas, opened its new municipal light plant July 3. Two 210-hp. Fairbanks-Morse diesels are the prime movers, and the plant was built by Inland Engrg. Co., Dallas, Texas, for $89,725, including distribution system

Phillips Petroleum Co., Burbank, Okla., has ordered five miles of 16-in. Naylor spiral-weld pipe for a gas vacuum line. American Natural Gasoline Co., Shamrock, Texas, has ordered several miles of 16-in. pipe for a pressure gas line.

The Pinnacles power project near Danville, Va., has been revived with a new survey, showing the possibility of building the desired plant for $2,750,000.

Bonneville Dam, on the Columbia River, Ore., has received its "second year" $11,000,000 allotment from PWA. Work started with an initial allotment of $20,000,000 last year, of which $12,000,000 has been used. According to present plans, the dam and six power units are to be built.

Camden, N. J., has received a PWA allotment of $6,000,000 as a loan and grant for a municipal power plant, provided the New Jersey Legislature enacts enabling legislation. The legislation is principally on bonds for purchase of existing systems and repayment of loans from revenues.

Piedmont Municipal Electric Co., Lincolnton, N. C., W. H. Childs, city attorney, in charge, has been organized by a group of municipalities in this district to construct and operate a new central steam-electric generating plant for light and power. Site is being selected. Initial capacity about 50,000 kw. Municipalities include Lincolnton, Lenoir, Hickory, Kings Mountain, Morganton, Granite Falls, Shelby and other towns, where distribution systems and facilities will be arranged, including power substations and switching stations. Entire project will cost about $6,500,000. Financing through Federal aid.

Board of Trustees, University of Washington, Seattle, will soon have plans drawn for a new central steam-operated electric power plant for service including light and power and central steam supply. A fund of $142,000 has been secured through Federal aid. Charles C. May, superintendent of buildings and grounds, in charge.

Fleetwood, Pa., has plans maturing for new municipal electric light and power plant and will proceed with program at early date. Fund of $148,000 has been arranged for building and equipment. J. W. Maskell, 947 East Rittenhouse St., Philadelphia, Pa., engineer.

U. S. Engineer Office, Pittsburgh, Pa., has preliminary plans under way for a new hydro-electric power plant in conjunction with the Tygarts Valley power dam, vicinity of Grafton, W. Va., to be built on the Tygarts River. The dam will have a height of 232 ft. from rock foundation to crest, with foundation width of 215 ft.; it will have a full width of 1,850 ft., and will be 20 ft. wide at top. Bids for construction are scheduled to be asked this month. Maj. D. W. Styer is district engineer in charge.

Modesto Irrigation District, Modesto, Calif., plans construction of a new circuit on transmission line from Don Pedro power house to power substation "A," in city, for increased power supply. Work is estimated to cost close to $60,000, and fund will be obtained from recent PWA loan and grant of $225,000, remainder to be used for extensions and improvements in irrigation system.

TVA has authorized initial surveys for proposed power dam and hydro-electric power development on Hiawassee River, vicinity of Murphy, Cherokee County, N. C., to include transmission lines, switching stations, power substations and other facilities, including flood control construction. Fund of about $13,000,000 will be used for project.

Middlesex Pipe Line Co., an interest of Sun Oil Co., 1608 Walnut St., Philadelphia, Pa., plans early construction of a new welded-steel pipe line from oil refinery of last-noted company to bulk terminal on the Passaic River, Newark, N. J., estimated to cost about $475,000. Line will be used for oil transmission between the two points, and will include

booster pumping stations. It will run from Marcus Hook, Pa., where refining plant is located, to Washington's Crossing, Pa., thence across the Delaware River and through New Jersey to terminus, a total distance of about 100 mi. Financing has been arranged.

Cumberland, Md., is considering a report submitted by the Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineers, for a new municipal electric light and power plant, estimated to cost $1,523,000. Preliminary surveys have been made. The Public Ownership League, Isaac Hirsch, chairman, is active in the program.

Plans are maturing for several power projects in Michigan. Menominee is having detailed plans drawn for a new municipal electric light and power plant, estimated to cost $803,000, with certain distribution facilities; a fund in that amount has been secured through Federal aid; Francis Engineering Co., Saginaw, is consulting engineer. Tecumseh is planning a municipal electric light and power plant to cost $166,000, and will have plans drawn at early date; financing in amount noted is being obtained through PWA loan and grant. Grand Rapids will make extensions and improvements in municipal pumping stations used for waterworks system, with installation of new motor-driven pumping machinery and auxiliary equipment; project will cost about $73,000; city engineering department is in charge. Morenci is having plans completed by Ayers, Lewis, Norris & May, Ann Arbor, consulting engineers, for a new municipal light and power plant, estimated to cost $125,000, with equipment, and in which amount financing has been arranged through Federal aid; it is expected to ask bids at early date.

Cleveland, Ohio, City Council is arranging an ordinance to provide for expansion and improvements in municipal electric light and power plant on Lake Erie and East Fifty-third St. Detailed list of new equipment to be installed and estimates of cost will soon be arranged. Project will approximate $2,000,000. Department of Public Utilities, William J. Rogers, director, is in charge.

Trenton, Mo., plans call for bids late in August for new municipal electric light and power plant, using diesel engine-generating units. An appropriation of $315,000 has been secured through Federal aid. Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., is consulting engineer.

Distillers Co., Ltd., Linden, N. J., an interest of company of same name at Glasgow, Scotland, represented by Howard Chapman, 420 Lexington Ave., New York, N. Y., architect, has authorized construction of steam power plant with radial brick stack at new multi-unit distillery on 5-acre tract of land on West Edgar Road, Linden, recently acquired. Project will represent investment of about $400,000, and work will be placed under way at early date. Architect noted is in charge.

State Board of Education, Des Moines, Iowa, plans installation of new electric generator unit and auxiliary equipment in power plant at Iowa State School for Blind, Vinton, Ia. Bids scheduled to be asked soon. Oren Thomas, 1618 Seventy-fifth St., Des Moines, is architect.

California Brewing Assn., 2060 East 49th St., Vernon, Los Angeles, Calif., has approved plans for construction of power plant at new multi-unit brewery. Entire project will cost about $450,000. E. L. Chaffe is engineer in charge.

Stoughton, Wis., will make early call for bids for equipment for extensions in municipal electric light and power plant, including new generating units and accessories for increased capacity. New standby unit will also be purchased. A fund of $125,000 has been authorized, portion to be secured through Federal loan. W. G. Kirchhoffer, 22 North Carroll St., Madison, Wis., is consulting engineer.

Chester, W. Va., is considering construction of new municipal electric light and power plant. Surveys and estimates of cost will soon be made, and financing arranged through Federal aid. Station is expected to cost over $100,000.

Kennett, Mo., plans call for bids this month for new municipal electric light and power plant, using diesel engine-generating units. An electrical distribution system will be built, for which bids will be asked at same time. Fund of $165,000 has been arranged for project. Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., is consulting engineer.

DIESEL AND SEMI-DIESEL ENGINES

The statement below, giving statistics on the production of diesel and semi-diesel engines in 1933, compiled from data collected in the Biennial Census of Manufactures taken in 1934, is released by the Bureau of the Census. All figures are preliminary and subject to revision.

At this census, in order to reduce the cost of the field work, an abbreviated schedule was used for the unimportant establishments in many industries, including the engine industry. This schedule called merely for data on employees and their compensation, cost of materials, fuel, etc., and total value of products, with no breakdown as to kind and quantity. The combined value of all products manufactured in 1933 by the nine manufacturers of diesel and semi-diesel engines who reported on the abbreviated schedule was $645,778, of which amount probably somewhat more than half represents the value of complete engines. Two sets of figures for 1931 are, therefore, given in the table below —one adjusted for comparison with 1933 and the other covering the total production of diesel and semi-diesel engines as reported by all manufacturers.

	Number of establishments reporting	Production of diesel and semi-diesel engines — Total — Number	Total — Rated horsepower capacity	Total — Value	Number, by horsepower capacity (rated or normal, not overload) — [1]5 or more but under 10	10 or more but under 20	20 or more but under 50	50 or more but under 100	100 or more but under 200	200 or more but under 400	400 or more but under 1,000	[1]1,000 or more but under 5,000
Total:												
1933	[2]22	1,144	139,191	$4,704,540	11	27	203	449	288	110	51	5
1931[3]	22	1,160	224,086	9,891,406	43	80	188	227	298	179	127	18
1931[4]	42	1,473	264,037	11,811,975	65	106	287	297	331	213	144	30
1933												
Diesel (compression-ignition), total	21	836	122,728	4,384,587	11	8	108	294	251	108	51	5
Marine—												
For direct connection to propeller shaft	12	147	27,515	1,235,327	..	..	17	34	52	29	13	2
For electric-drive and auxiliary use	6	61	13,580	602,437	..	4	9	4	16	16	12	..
Other diesel—												
Stationary	14	567	66,505	2,260,115	11	4	82	256	140	56	15	3
Other (tractor and aircraft; railway diesel-electric)[5]	4	61	15,128	286,708	..	..	...	...	43	7	11	..
Semi-diesel (surface-ignition—hot-spot hot-bulb, etc)[5]	5	308	16,463	319,953	..	19	95	155	37	2	..	..

[1]No diesel or semi-diesel engines rated at less than 5 hp. or at 5,000 hp. or more were reported.

[2]The difference between the net total number of plants engaged in the manufacture of diesel and semi-diesel engines, 22, and the sum of the numbers engaged in manufacture of the various types listed, 41, is due to the fact that 19 of the plants either made two or more types of diesel or manufactured both diesel and semi-diesel engines.

[3]The figures given in this line are the 1931 totals for those establishments which reported in detail for 1933, and are, therefore, comparable with the 1933 totals given immediately above. (See second paragraph of text.)

[4]Total for all establishments which reported the manufacture of diesel and semi-diesel engines for 1931.

[5]Not including diesel engines made and installed by same establishments.

[6]Separate data were collected for industrial portable and stationary engines and for other types, but it was necessary to combine them in order to avoid disclosing approximations of the data for individual establishments.

NEW BULLETINS

Power Transmission — Boston Gear Works, Inc., 151 Lafayette St., New York, N. Y. Catalog 50 gives 250 pages of data on gears, speed reducers, chain drives, ball bearings, and other power transmission elements available from stock.

Fortieth Anniversary—Neiler, Rich & Co., engineers, Chicago, celebrate their Fortieth Anniversary with a 20-page booklet, impressively listing jobs handled by this firm.

Fractional Horsepower Motors—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Three leaflets describing Type FR repulsion-start induction motors, Type FK direct-current motors and Type FS polyphase squirrel-cage motors.

Stoker—Niagara Combustion Corp., Niagara Falls, N. Y. Niagara Overfeed Sprinkler Stoker illustrated and described in 12-page special catalog.

Mining Cable—General Electric Co., Schenectady, N. Y. GEA-1920 lists telephone and power cable for mine and similar uses.

Arc Welding—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Arc Welding Data Bulletin No. 18. 28-page illustrated bulletin of typical and outstanding applications. Types of equipment.

Water Turbines—James Leffel & Co., Springfield, Ohio. Bulletin 32, "Leffel Turbine-Water Wheels," contains 32 pages of illustrations and data regarding these wheels.

Temperature Control—Brown Instrument Co., Philadelphia, Pa. Folder 85-10, "For You Who Use Heat in Plant Processes," illustrates the importance of automatic temperature control. Also Catalog 1101 and others listed in bulletin.

Lighting—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Industrial check charts with standards for illumination of industrial interiors.

Emergency Power—Electric Storage Battery Co., Allegheny Ave. & 19th St., Philadelphia, Pa. Form 3619, "Behind These Lights is the Emergency Protection of Exide Batteries," well illustrated, gives examples of installations.

Transformers—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. 8-page bulletin on surge-proof transformers.

Motors—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Leaflet showing different types of synchronous motors and torques.

Capacity Meter—James G. Biddle Co., 1211-13 Arch St., Philadelphia, Pa. Bulletin 1375, "Megger" Capacity Meter, 2 pages. Description, ranges and specifications. Also Bulletin 1380, Midget "Megger" Circuit Testing Ohmmeters, 2 pages.

Instruments—Paul B. Huyette Co., Inc., 401 N. Broad St., Philadelphia, Pa. Catalogue A-34, "Power Plant Equipment Instruments," 24 pages. Descriptions, specifications.

Air Filter—Staynew Filter Corp., Rochester, N. Y. Folder on "Protectovent" air filter for office and building windows.

Instruments — Esterline-Angus Co., Indianapolis, Ind. Form No. 1302 is No. 2 of an interesting series on "Solving Industrial Crimes," describing savings in power cost resulting from instruments.

Rotary Pumps—Worthington Pump & Machinery Corp., Harrison, N. J. D-475-B9 is a 2-page bulletin on internal-bearing, double-helical rotary pumps.

Motors—Lincoln Electric Co., Coit Rd. & Kirby Ave., Cleveland, Ohio. 4-page bulletin, "Heat Conquered by Lincoln "Linc-Weld" Self-Protecting Motors."

Variable-Speed Transmission — Reeves Pulley Co., Columbus, Ind. 16-page T-6700 gives features of Reeves unit and comparative data. Booklet trimmed to transmission shape.

Tube Couplings — Parker Appliance Co., 10320 Berea Rd., Cleveland, Ohio. 64-page Bulletin 37 is a price list on Parker tube couplings and associated equipment. Bulletin 35 has 35 pages showing features of Parker equipment in industrial plumbing. Bulletin 28, punched for binding, 28 pages, discusses tube fabrication and equipment.

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ark., Osceola—City, A. S. Rogers, mayor, making plans electric light and power plant. $52,000. M. C. Baumann, engr. P.W.A. project.

Ill., Highland—City soon takes bids light and power plant. $25,000 grant and loan allotted by P.W.A.

Ill., Naperville—City plans alterations and additions to power generating plant, incl. electric equipment, two 500 hp. diesel engines, $80,700. Allen & Vogtborg, 205 West Wacker Dr., Chicago, engrs.

Ill., Waukegan—Alexian Bros. Hospital, c/o Brother Gerard, provincial superior, 1200 Bladen Ave., Chicago, plans by Maher & McGrew, 1564 Sherman Ave., Evanston, and takes bids about Sept. 1, 3 and 4 story noviate building, power house and generating plant, Holdridge Rd. and Lewis Ave., northwest of here. $600,000.

Ia., Des Moines—City did not hold election June 4 and no action has been taken since that time to vote on $3,000,000 revenue bonds for acquiring, maintaining and operating municipal light and power plant.

Ia., Glidden—City voted to construct municipal light and power plant. $47,500.

Kan., Oswatomie—City plans water and electric light plant. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs. P.W.A. approved loan and grant.

Md., Cumberland—City making plans municipal light plant. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Mich., Allegan—Plans completed for municipal power plant and distribution system. Injunction restraining city from proceeding with power plant lifted. Est. $410,000. Ayres, Lewis, Norris & May, Cornwall Bldg., Ann Arbor, engrs.

Mich., Unionville—Robert Gage Coal Co. plans coal mine structures, incl. installation of two 600 hp. vertical tube boilers, etc. Private plans.

Minn., St. Cloud—City plans municipal power plant. P.W.A. funds allotted. $1,250,000. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Minn., Worthington—City, W. H. Buchan, clk., making plans furnishing, installing turbine generator in power plant. $30,000. C. Foster, 512 Sellwood Bldg., Duluth, engr.

Mo., Hannibal—City, c/o W. S. Watson, supt. Bd. P. Wks., soon takes bids light and power plant improvements, incl. one 7,500 kw. steam turbine generator, surface condenser with auxiliaries, foundation and other concrete work, piping and electrical wiring. $270,000. P.W.A. allotted $81,000 grant. Baumes-McDevitt, Railway Exch. Bldg., St. Louis, consult. engrs.

Mo., Independence—City, R. F. Sermon, mayor, soon takes bids municipal light and power plant addition and equipment. $187,805. P.W.A. funds allotted. Veatch, 700 Mutual Bldg., Kansas City, engrs.

Mo., Konnett—City bids in August, municipal power plant. $165,000. Burns & McDonnell Eng. Co., 107 Linwood Blvd., Kansas City, Mo. engrs.

Mo., Moberly—City Council, election Sept. 11, $566,000, municipal light and power plant. Est. $700,000 P.W.A. funds allotted. Russell & Axon, Roosevelt Bldg., St. Louis, consult. engrs. Noted June 21.

Mo., Monroe City—City plans extending and improving light plant. $60,000. $17,000 grant approved by P.W.A. W. B. Rollins & Co., 339 Railway Exchange Bldg., Kansas City, engrs.

Mo., Trenton—City bids in August, diesel engine, power plant. $315,000. P.W.A. project. Burns & McDonnell Eng. Co., 107 Linwood Blvd., Kansas City, engrs.

Neb., Ord—North Loup Hydro-Electric & Irrigation Dist., Lincoln, application for P.W.A. loan for 4 mi. main canal with reservoir and power unit, near Sioux Creek between Order and Taylor. $3,000,000 has been rejected. Black & Veatch, Mutual Bldg., Kansas City, Mo., engrs.

N. Y., Auburn—City making plans power plant. $310,000 P.W.A. loan allotted. J. Tehan, city engr. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., consult. engrs.

N. Y., Greig—Otter Creek Power Co., c/o Northern New York Utilities, Inc., Watertown, plans electric power plant and lines here and in Lewis Co. To exceed $28,000.

N. C., Lincolnton—City, filed application with P.W.A. for loan to finance construction of municipal power plant. Est. $6,000,000.

Ohio—Buckeye Co-Operativille Homesteads Assn., J. S. Green, 1136 Standard Bank Bldg., constructing 500 homes, central power plant, 2 factories, sewers, roads, waterlines, at Subsistence Farms, in Geauga and Portage Counties. $3,000,000. Applied for Government loan. Private plans.

O., Cleveland—City, W. J. Rogers, dir. P. Utilities, plans repairing and expanding municipal light plant, and new equipment at foot of East 53rd St. $250,000. L. A. Quayle, 105 City Hall, engr.

O., Hiram—Village, H. Bancroft, clk., making plans municipal light plant. $32,500. R. Husselman, Hippodrome Bldg., Cleveland, archt. and engr. P.W.A. loan granted.

Okla., Cushing—City making plans and takes probably in September, municipal light and power plant, incl. diesel engine 2,250 hp. and distribution system. $350,000. P.W.A. funds allotted. J. W. Flint, city mgr. W. R. Holway, 302 East 18th St., Tulsa, consult. engr.

Pa., Ambridge—Borough Council, plans being revised for construction municipal electric light and power plant. To exceed $75,000.

Pa., Coraopolis—City plans electric power plant. P. F. Loftus, Oliver Bldg., Pittsburgh, engrs.

Pa., Jeanette—Borough Council authorized survey of information on cost for construction of municipal light and power plant.

Pa., Rockwood—Associated Gas & Electric Co., 61 Bway., New York, and Rockwood, plans rebuilding power plant destroyed by fire. $250,000. Private plans.

†Texas—Colorado River Co., San Antonio, c/o U. S. River & Harbors Dpt., Wash., D. C., plans reservoir and dam on Colorado River, near Bluffton, for irrigation, power generation, municipal water supply, etc. $4,500,000 P.W.A. allotment granted.

Tex., Colorado—City preliminary surveys municipal light and power plant. $257,000.

Tex., Eagle Pass—Maverick Co. Water Control & Impvt. Dist. 1, c/o Dr. Van E. McGarland, pres. Bd., plans restoring portion 32 mi. canal for power and irrigation and completion of system. $2,421,875 P.W.A. allotment approved. Myers, Noyes & Forrest, Tower Petroleum Bldg., Dallas, engrs.

Tex., Morton—City plans electric light plant and distribution system. $23,000 approved by P.W.A. H. N. Roberts, Lubbock, engr.

Wis., Manitowoc—City making plans light plant improvements. $200,000. Burns & McDonnell Eng. Co., 107 West Inwood Blvd., Kansas City, Mo., engrs.

Ont., Ste. Catherines—P. B. Yates, chn. P. Utilities Comn., soon takes bids construction and equipment of 12,000 volt sub-station.

B. C., Victoria—Victoria Steam Heating Co. plans central heating plant. P. Fox, Victoria, engr.